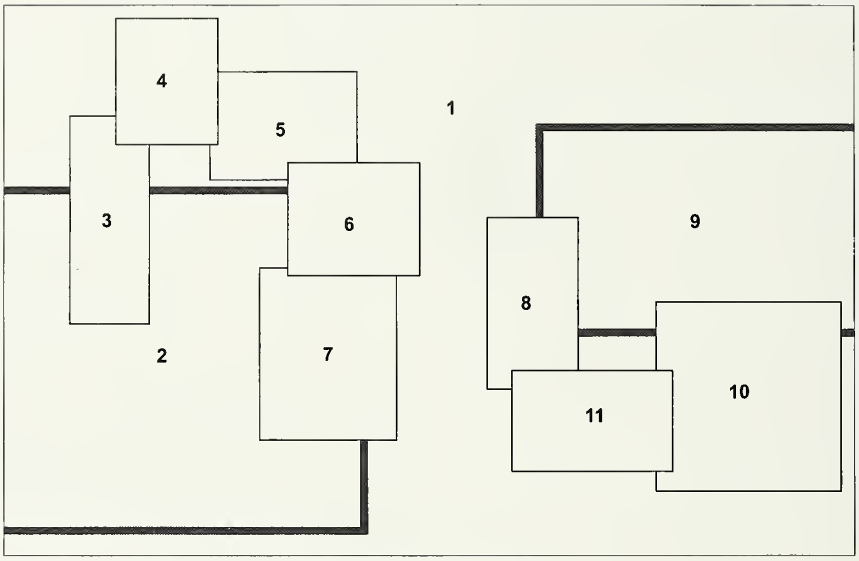
Geology for a New Generation

Illinois State Geological Survey

Annual Report 1998



Cover photos by Joel Dexter, Mike Knapp, and Ellen Wolf

1 & 2 Rock hounds at the Waterloo Quarry, Monroe County.

3 & 4 Collecting specimens of Devonian limestone (about 300 million years old) on the Elizabeth field trip, Jo Daviess County.

5 Nicole Butler-Proch, 4th grader, hits the ISGS Home Page while she's surfing the Internet.

6 Earth-science field trip for school kids in the Pontiac-Streator area, La Salle and Livingston Counties.

7 Examining an exposure of Ordovician dolomite (about 400 million years old) on the Savannah field trip, Carroll County.

8 Outside the Annex, the GeoSurvey's warehouse for rock cores, kids struggle turning a hand auger to bore into the hard ground and pull up a soil core. The hands-on demonstration was part of "a day at the Scientific Surveys" for Chicago youngsters.

9 On the Morris field trip, Grundy County, people take a close look at a glacial moraine on the north side of White Willow Road.

10 Old Stone Face, Shawnee National Forest, southeastern Illinois.

11 Kids hunt for interesting rocks at a sand and gravel quarry on the Shelbyville field trip, Shelby County.

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

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Geology for a New Generation

To the people of Illinois

Illinois State Geological Survey Annual Report, 1998

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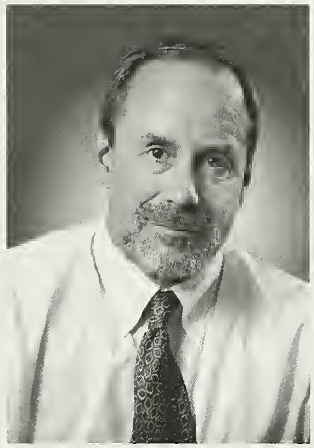
The foundation What holds up your house? What if you could cut through the earth and take a look? *[Computer simulation by Joel Dexter: there's no house on this site—only in the computer.]*

To the people of Illinois

Bridging the gap

Illinois is blessed with a State-supported scientific establishment dedicated to responsible development, management, and protection of earth resources. The Illinois Department of Natural Resources (DNR) works diligently to manage and protect the State's natural areas and to acquire and reconstruct terrains with unique ecosystems such as watersheds and wetlands [p. 31-33] that can be enjoyed and used by future generations.

The State Geological Survey, as a division of DNR, has become more deeply involved in providing the scientific information relevant to ecosystem management and reconstruction than ever before.



"Society is founded on earth resources," Chief Shilts says, "and the science of earth is geology."

One challenge to this important activity is that our landscape has been greatly modified by agricultural activity, urban growth, and industrial enterprise.

Another challenge is the complex nature of our geology. Illinois' rich soils formed on thick glacial deposits, which include the sand and gravel aquifers that hold our most precious natural resource—water. Sand and gravel deposits are also in demand as construction aggregate; and under the glacial cover lie other valuable resources, such as oil, coal, and the high-quality carbonate rocks needed for construction aggregate, agricultural lime, and flue-gas desulfurization [p. 43]. Multiple uses, combined with high demand, for these natural resources often result in controversy over their fate—especially when they are located in settings that are associated with unique ecosystems or are prime sites for urban expansion.

The Geological Survey often finds itself in the role of mediator—bridging the gap between advocates of economic growth and supporters of environmental well-being.

In this role, the Survey can provide objective data and interpretations relevant to the geologic issues. We are unique in being staffed by scientists who have extensive knowledge of the extraction and development industries [p. 37-44], and scientists who are national leaders in the application of geology to land-use planning, water production and protection [p. 26-28], and ecosystem maintenance and restoration [p. 30-34]. We offer geologic information that can allow the proponents of all sides of an issue to achieve meaningful and mutually satisfactory outcomes.

Base of support

The most daunting challenge we face is to fully map the geologic foundations of Illinois [computer simulation left]. In particular, the glacial geology of much of the state is in dire need of modern mapping in three dimensions and at a scale of 1:24,000 (1 inch on the map = 2,000 feet on the ground). The thick layer of glacial sediments—sand, gravel, silt, and clay—obscures the underlying bedrock and obstructs our efforts to map by traditional methods.

We share this problem with our neighbors, the other central Great Lakes states.

A State/Federal coalition has been developed to conduct three-dimensional, 1:24,000-scale mapping of the glacial geology of high-priority areas in Illinois, Indiana, Michigan, and Ohio. The Central Great Lakes Geologic Mapping Coalition will pool the material, financial, and human resources of these four State Geological Surveys and the U.S. Geological Survey (USGS) to accomplish this significant mapping over the next decade and a half. The USGS is promoting the Coalition as a model of how they intend to interact with States in the future.

At the Geological Survey in Illinois, we are in the final stages of preparing new digital map products that represent three-dimensional mapping projects, one in the Villa Grove area of Illinois and the other in the Vincennes area of Illinois and Indiana. During 1997–1998, three-dimensional mapping [p. 18–20] extended into the Kellerville Quadrangle (western Illinois), Oak Hill Quadrangle (middle of Peoria County), Crystal Lake and McHenry Quadrangles (in McHenry County, a Chicago collar county), and the Metro East area (Madison, St. Clair, and Monroe Counties, across the Mississippi River from St. Louis).

All geologically based enterprises in Illinois will benefit in many ways from this program. Access to meaningful, easily understood information in digital form will provide the objective, scientific basis for significantly improving urban planning, resource development, groundwater protection, waste disposal, geohazard emergency management (flooding, landslides, earthquakes), ecological planning, and other critical environmental and economic decisions.

Best interests of the people

"Geologic mapping for county projects, such as finding new sources of public water supplies, is one of our major activities," Chief Shilts says, answering a caller's question about aquifers during a talk show on public radio, WILL-AM 580, at the University of Illinois. Host David Inge asks Shilts about the work of the Geological Survey. "We're a resource that communities can draw on."

We must go out of our way to explain what we're doing for the people of Illinois. It's our responsibility to explain how they get very good return on their investment in the Geological Survey. It's also in our best interests to help people understand the impact of geologic research on their lives.

We need to use the same language as our "clients"—to talk about any type of geologic research at public meetings, in classrooms, on TV or the radio, as well as out in the field—wherever people are debating earth-environmental issues or trying to solve earth-related problems.

A new, important task we've taken on this past year is the training of public school teachers in Illinois' geology, so they can implement the new Learning Standards for Science mandated by the State Board of Education. The highly successful, well-attended workshops created by our staff [see p. 15] demonstrate that we are national leaders in this increasingly important evolution of earth science curricula. Making the connection between geology-in-books and geology-in-our-lives is the goal of the Survey's education and outreach program [p. 12-17]. We're trying to "bring geology home" to kids—and their families.

As we acknowledge the unique position and value of the Geological Survey to the State of Illinois, we also accept our responsibility to be national leaders in resolving natural resource issues at all levels. Let's never pass up an opportunity to explain our work to friends and neighbors—and especially to our children. The more people understand what we do, the more they'll say "that's good, it's really worth the effort."

William W. Shilts

William W. Shilts, Chief

"We have a strong management and administrative team. They have a deep understanding and commitment to the Geological Survey," says Chief Shilts, during his annual State-of-the-Survey talk with staff. "I have no reservations about trusting this team to represent our interests well."

Wise investment

E. Donald McKay

Geologists Don McKay, Dan Nelson, and Curt Abert check the printout of a digital map of Illinois' bedrock deposits.

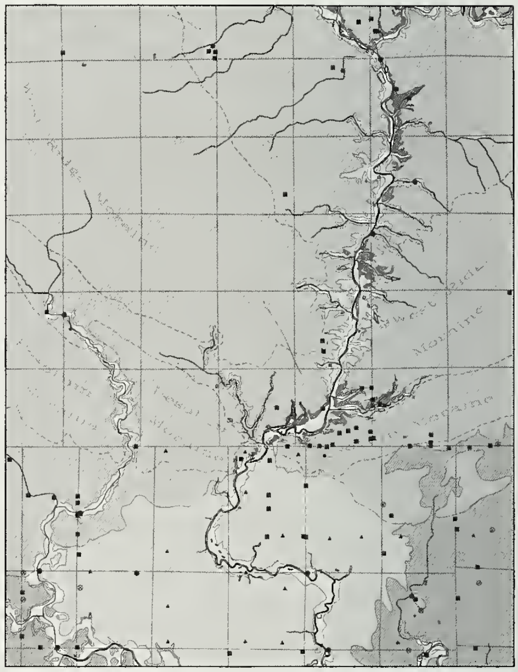
During the past century, Illinois invested significant resources in its Geological Survey, a unique public institution.

"Today, our information and expertise are more important than ever to help solve pressing environmental and economic issues," says geologist Don McKay, director of the basic research group dealing with glacial deposits, bedrock, groundwater, wetlands and watersheds, and computer mapping. "We provide geologic data and interpretations to government, business and industry, and the public. To communicate our scientific results effectively, we use the latest maps and technologies."

Scientific inquiry, by its nature, offers no certain outcomes, McKay points out. "But the Survey's objective is always to conduct research that prepares us for the next questions that people will ask about their earth environment. We seek to anticipate society's needs."

"The 'old' way of mapping?"

McKay stops to think. "A map of glacial or bedrock geology used to show little more than what we find at the surface." The traditional methods of mapping were based on exposures in stream banks, roadcuts, mines, quarries, and other excavations. Geologists would infer from their observations what rock strata lay at depth between the outcrops. By adding information from old and new drilling records, rock cores and samples, and recordings of sound waves or electrical current passing through earth materials, they could interpret and map the subsurface geologic framework of a region in great detail.



Glacial geology of the Villa Grove quadrangle [definition, p.18]: two-dimensional map.

"A geologist might know that a buried stream valley lies, say, at 400 feet deep," he explains. "But the conventional two-dimensional map only indicated, by implication, what's at depth.

"We'd use a cross section to extend our surface mapping into the subsurface." Cross sections are simply cutaways of a narrow strip of land from point to point—really just another two-dimensional view of the subsurface—as if the face of a quarry stretched for miles across the land.

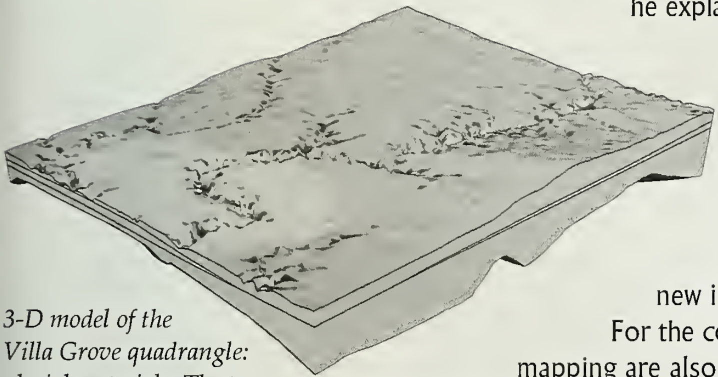
Stack-units, the next development, are still a useful way to depict the geology of some areas. "A stack-unit map has patterns, colors, and alphanumeric codes representing materials—and sometimes the properties of those materials—from land surface to a certain depth," McKay says. "Unfortunately, the generalization required for stack-unit mapping must omit significant details and limits us to a depth of 50 or 100 feet, in order to make the map readable." But in most of Illinois, the glacial deposits range between 100 and 500 feet deep, which limits the usefulness of the stack-unit method.

Bedrock geology of the Villa Grove quadrangle: two-dimensional map.

Stack-unit methods are most useful for mapping the sand, silt, gravel, and clay lying near land surface, and he adds, "for showing where shallow aquifers are 'sensitive' to contamination."

Three-dimensional (3-D) mapping expands on the two-dimensional and stack-unit approaches in the scope of subsurface data gathering, means of storage and processing, and types of products.

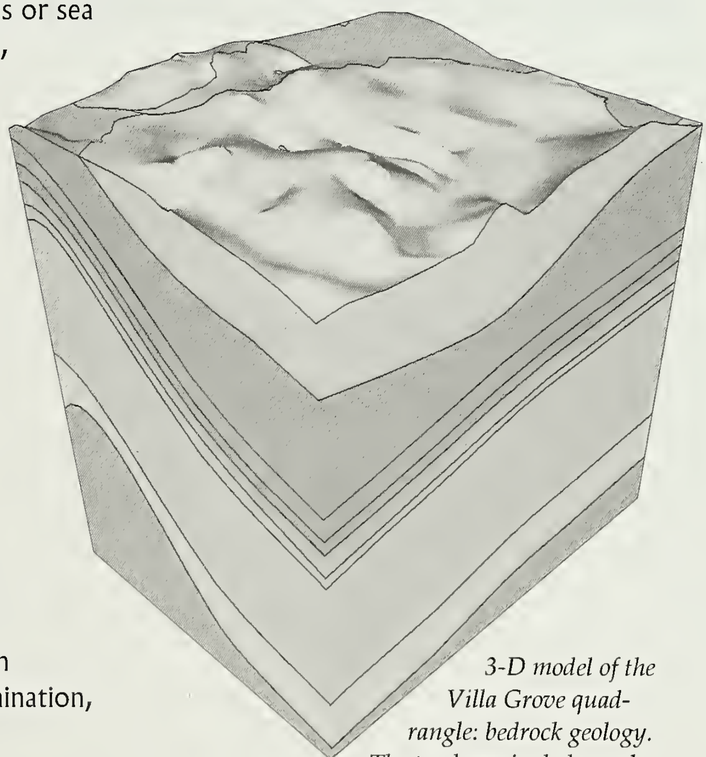
"The computer is part of the process from the beginning," says McKay. Saving his computers-in-the-field discussion for another day, he focuses on the power of digital systems to handle vast amounts of borehole and geophysical data. "In the computer, everything comes together. We integrate all the data on location, thickness, distribution, and properties of the geologic materials in an area selected for study. For visualizing the study area, we have choices that help us portray complex patterns without overgeneralizing. We can make multiple maps that 'slice' the geology horizontally, vertically, or at an angle," he explains, "or we can create a 3-D model that shows, on-screen, a cubic view of our study area." The difference between these 3-D computer maps or models and an artist's renderings is that the computer versions are initially "drawn" directly from the database. An added feature of digital maps and models is the ease of updating or modification, as new information is entered into the database.



3-D model of the Villa Grove quadrangle: glacial materials. The top layer is sand, gravel, silt, and clay from the latest glaciation, the Wisconsin Episode. The thin layer in the middle was deposited during the Illinois Episode of glaciation. The bottom layer consists of Pre-Illinoian glacial deposits.

For the consumer, the products of three-dimensional mapping are also a giant step forward. Land-use planners, government officials at all levels, environmentalists, business people, farmers, and other landowners will have access to a suite of maps that tells them all they need to know about the earth under their feet; for example, the type of soil, location of water-yielding deposits, nature of bedrock layers (many marking ancient land surfaces or sea floors), and areas of coal, oil, sand, gravel, and stone resources. From these basic maps, geologists will derive a subset, called "derivative maps," that evaluate the quality, quantity, and availability of a resource (for example, high-quality limestone or low-sulfur coal), or rate earth materials for their susceptibility to contamination, erosion, or seismic shaking.

Geologic-vegematic
It slices! It dices! It extracts volumes! "Once we have our 3-D models built," says geologist Curt Abert, "we can slice, dice, rotate, or cut cross sections wherever and however we choose."



3-D model of the Villa Grove quadrangle: bedrock geology. The top layer is shale, coal, clay and some sandstone and limestone—all from the coal-swamp period called the Pennsylvanian. The next layer contains siltstone, sandstone, and limestone from the Mississippian Period when shallow seas covered the midcontinent. The underlying layers are shale, limestone, dolomite, and sandstone to 1,300 feet below sea level.

Servicing our map products

"People who aren't used to reading geologic maps usually need some help," McKay explains. "After we've made a map for an area, we go there, present the product to the county or communities, and follow up with assistance in interpreting it.

"We must understand the local problems—ranging from environmental to political—as well as provide the geologic information."

A few years ago, when McKay worked with a central Illinois county on a landfill siting study, he gave the site-selection committee a full presentation on geology-for-planning.

"We offered them a whole suite of geologic products for planning in a regional context," he says. "But the committee had economic and legal constraints that didn't allow them to spend money for the 'full-meal deal.' They had to make a decision quickly to evaluate and buy property."

Bedrock geologist Joe Devera [center] shows Don McKay the surface evidence of subsurface faults.

Targeting customer needs, the GeoSurvey tapped into its substantial database on central Illinois and produced maps of surface and near-surface earth materials. "Then we worked with the committee to produce derivative maps that met their immediate needs," says McKay.

The focus was landfill siting, but the maps applied to many water resource issues. "That's one of the major uses of geologic maps in this part of the world," he explains, "to identify and protect groundwater resources.

"Investment in large-scale geologic mapping, whether for landfill siting or another specific reason, can serve many purposes for years to come. We have to be committed to the long-term—to the economic and environmental returns for our children."

"You name it, we've got it—here in the Midwest!"

Richard C. Berg

Dick Berg, director of the GeoSurvey's three-dimensional mapping program, "highlights" a long list of interdependent societal and geologic factors: "High population, high industrial output, high agricultural productivity—thanks to some of the best soils in the world, high dependency on abundant groundwater resources, and an unfortunately high number of waste-disposal and contamination problems.

"The central states have more than a fair share of geologic hazards," he adds [p. 21-23]. "Along all the rivers and lakes, there's a high potential for flooding and shoreline or soil erosion."

Last but not least is the risk of earthquakes, which is quite high in southern Illinois [p. 24-25].

"Our abundant deposits of sand, gravel, and high-quality stone are in high demand for construction," Dick Berg says, "from rural homes and highways to city streets and skyscrapers, to river levees and lake-shore defense."

The Midwest/Great Lakes region is the only part of the country where all these socio-geologic conditions affecting the quality of life "come together in a big way," as Berg puts it. This confluence of factors occurs in areas of "glacial drift," the unconsolidated sediments that cover most of the region's bedrock: sand, gravel, silt, and clay deposited during and since the Ice Age by wind, water, and ice.

"The thick cover of largely glacial sediments is so complex, it's tough to describe, map, and interpret," he says, "so people can understand how it applies to their lives."

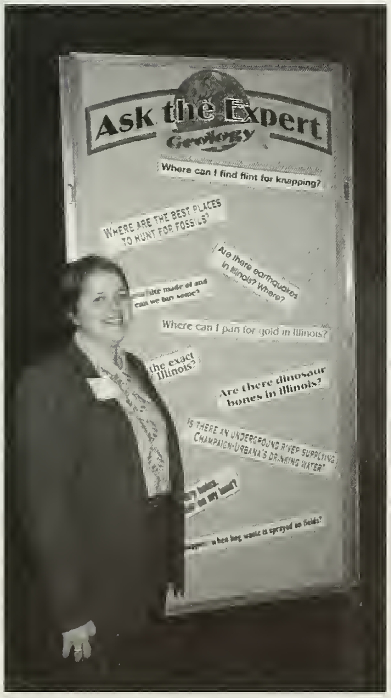
Dealing with all land-use issues depends on a detailed knowledge of glacial geology in three dimensions (length, breadth, and depth), and even the fourth dimension—through time.

Geologists Dick Berg and Ardith Hansel examine an exposure of glacial materials at a sand and gravel pit.

High quality, high value

Beverly L. Herzog

"Groundwater is the source of drinking water for about half the people in Illinois," says senior geologist Bev Herzog, head of the research group dealing with mineral resources, chemistry, and geoscience engineering.



Bev Herzog, specialist in ground-water geology, did her share of answering tough questions at the Scientific Surveys' Science Fair.

"Some areas of Illinois are water-rich," she adds, and that's where water worries are more about protecting the resource than about finding new supplies.

Even where a sand and gravel aquifer is well protected under a thick mantle of clayey materials, people get alarmed about any threat to the resource—even the most remote possibility of contamination.

"When people know they have a high-quality water resource," says Herzog, "they want to keep it that way."

"Suppose a county's trying to isolate its wastes—put them safely out of the way for thousands of years. They pick a site where they think the geology looks right," she says, "but when our geochemists test the water samples, they may find the isotope tritium." She explains that tritium has been in the atmosphere only since nuclear-bomb testing in the 1940s and 50s. "Tritium in the aquifer means that rainwater moves through the site relatively fast." It's not an ideal spot for a landfill.

"Maybe we're trying to trace the source of gas causing damage to a farmer's crops. Is it from a local landfill, underground gas storage, or a naturally occurring source?" Herzog says [p. 35]: "We can tell by analyzing isotopes."

Quantity, not water quality, is the primary concern in other places. "Two cities in a mid-state county are planning to develop a well field within the next 20 years. So they came to us in the 1990s," she says [p. 27]. "They want to know: do we have enough water for our long-term needs—at least the next 50 years? Can we get it from groundwater? If we can, what will be the impact on existing well owners?"

In the field, Herzog uses a diagram of underlying rock strata to help explain the region's mineral resources to GeoSurvey "clients."

The Illinois GeoSurvey, together with the Water Survey, recently completed an impartial study that county planners, government officials, and landowners can use for rational discussion.

Competing interests for land

Good sources of crushed stone or sand and gravel aren't found everywhere, which makes the GeoSurvey's aggregate resource maps valuable for land-use planning.

"Aggregates are fairly cheap to mine. The expense is in transporting them to construction sites," Herzog says. "So it may not make sense to build a subdivision over what might be the only aggregate resource in a high-growth area.

"But we have many clients. Some don't want quarries in the neighborhood for environmental or aesthetic reasons," she adds [p. 19, 37]. "Suppose a quarry is mining stone near a wetland: is it at risk? Are there other aggregate sources nearby to support growth in local communities?"

The GeoSurvey is responsible to all the people of Illinois. "It's not our business to take sides," she says. "We do resource mapping and provide the geologic information to help resolve these issues. But people have to make their own decisions."

"Work done in energy and environmental engineering may seem remote from resource mapping," says group head Herzog [p. 43-44]. "But our geo-engineers and chemists are trying to solve some of the problems caused by using Illinois coal. Our research focuses primarily on two areas: first, on removing sources of pollution due to burning coal, and second, on turning coal wastes into usable products."

Jobs versus environment?

"What are the costs associated with various value judgments?" asks Herzog, citing another example: "Last year, the economic development council of Kankakee County asked the Survey to assess the potential for mining sand deposits in an area of sand dunes." Researchers in the Industrial Minerals and Resource Economics

Section did a field study [p. 38], complete with boreholes and sample collection, then conducted lab tests for chemical and mineral content. They found silica sand and some feldspar.

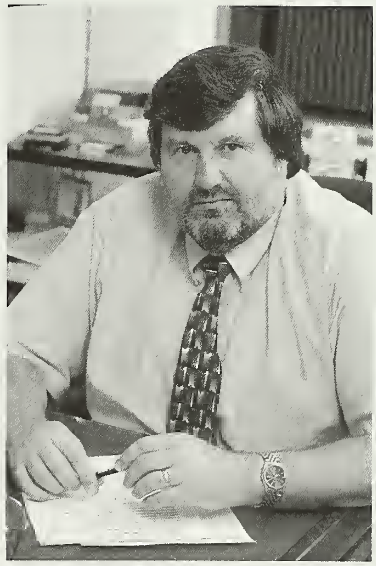
"So they put together a couple of scenarios based on processing these materials for different markets," she says. "The results were promising."

Later, the GeoSurvey discovered that another group wanted the sand dunes made into a nature preserve.

"Wherever there are competing interests for the same land, people have to make value judgments," Herzog says. "But we want them to know the geologic facts—they can always turn to us for help in understanding the earth issues."

Our mission? Support earth science needs of people

David L. Gross



"We provide the geologic information that allows people to do things in the best possible way," says Dave Gross, "as they see fit."

"We're in the business of fitting people and their needs with the landscape," says Dave Gross, assistant chief for strategic planning. He talks about meeting people's needs for geologic information at different levels, ranging from statewide concerns over pesticide contamination [p. 30-31] to local interests in quarrying stone. "We have to be available to interpret the data, respond to questions, and assist users with their problems."

The GeoSurvey also has a responsibility to deliver information in formats that people can use. "It starts with language. We know that using our own jargon is not the best approach." But communication is more than plain-speaking. People who understand what we're saying may not understand why it's important.

"We have to speak publicly for the longer term," he says. "We are responsible for explaining the continuing need to build geologic data sets, for making it clear that protecting groundwater is a long-term endeavor, for analyzing the energy options of the State in a global context."

Long-term planning is also the key to sustainable development of the State's and local economies. "When we evaluate the mineral or groundwater resources of an area, we look at the growth patterns of cities and industries," Gross says. "Is development cutting off access to resources that will be needed in the future?" He lists sand, gravel, and stone (for all types of construction), coal (for generating 60% of the nation's electricity; p. 41), and productive farmland.

"Is urban or suburban growth forcing the need to find new water supplies? Are some rural enterprises, such as corporate hog farms, threatening the water quality?" [See p. 32.] Gross shakes his head. "There's no point in lamenting the changes in society. We simply deal with them, today and tomorrow, by doing what we do best: collecting the geologic information essential to ensure economic and environmental security in the decades ahead."

Change is good

"The science progresses." Dave Gross lists advances in collecting and processing geologic data. "Drilling test holes and taking samples gets easier with equipment like the new drill rigs. Collecting subsurface information with geophysics—that technology's gotten better," he says, referring to methods of using electrical currents, sound waves, and gravity and magnetic fields to "map" the underground. "Of course, our chemical instrumentation continues to improve." [See p. 35.]

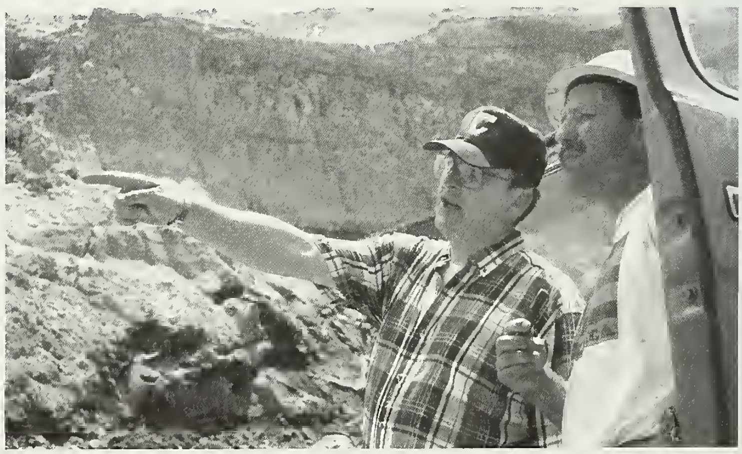
"We process a lot of information to make maps and provide analyses for public policy- and decision-making. The revolutionary increases in computing capacity and access to high-power, high-speed systems have been a boost for our work."

Today, society demands rapid response and easy access. "Much of our data is already in electronic form—locations of hundreds of thousands of drill-holes and water-wells, and topographic maps and samples," Gross says. "These data sets, and many of our geologic maps, are now available for prompt transmission through the Internet." He tells how the newest option for delivery of information is proving useful at Fermi National Accelerator Laboratory in Batavia, Illinois: "We're talking to scientists who work with high-energy physics machines, which have to be underground. They're fitting the design of their machine with the reality of the landscape. So we're teaching them how to access our data sets online." He adds, "We've opened the door to a vast storehouse of useful information via the Internet."

Through all these changes, the need for a State Geological Survey has increased substantially. "All states have geological surveys," Gross points out. "The Association of American State Geologists has 51 members." That tally includes Puerto Rico with its three-person agency. "Almost every nation has a geological survey. They're all concerned with the economic and environmental aspects of their natural resource base." He repeats: "These concerns are common to all states, all nations."

Custom support services

Gerald E. Glogowski



Jerry Glogowski consults with geologist Tim Young on the drilling operation at a clay pit in Olmstead, Pulaski County.

"Expertise that results in something positive for the scientists we're helping," is how Jerry Glogowski describes the contributions of his group, which handles everything from business and finance to maintenance, operations, and design.

"Last year, we expanded our drilling operations to support mapping in the field." Two years ago, Glogowski heard that the Illinois Environmental Protection Agency had some drill rigs that the GeoSurvey might put to good use [p. 19]. "After a lot of work by a lot of people, we got two rigs—large, heavy-duty rigs that'll go down a thousand feet into bedrock."


Myrna Killey and Russ Jacobson show Glogowski a core of clay pulled during drilling in western Illinois. Right: heavy-duty rig with its operator, Jim Neal.

It's not a shoestring operation. "We're making a big commitment in time and money to get this equipment into shape," he says. "The guys in the shop are very good at tearing things apart and putting them back better than new. But they're also involved in the drilling operation—it takes a crew of two to three people to run the big rigs. "We serve on specialized teams that study geology at depth," Glogowski explains, "and these drill rigs are the right tools for the job."

"We customize our services to meet the needs of people we used to be working for,*" Glogowski says, "but now we're working* with.*"*

High marks, high hopes

The GeoSurvey's manager of financial services gets high marks from Glogowski for working out funding for programs like the expansion of drilling.

Finance and human resources people have been preparing for the upgrade to a larger, more comprehensive computer system linking the Survey with the University of Illinois and State Departments in Springfield. Expectations are high for speedier, more efficient communications and information transfer.

Also looking ahead, the maintenance and operations staff is making plans for the next major phase of renovation and expansion (as early as 2002), when the Natural History Survey (NHS) moves to new quarters. Meanwhile, they're busy with drilling, wood- and steel-working, welding, electronics, and maintenance of 150 vehicles (39 belonging to the GeoSurvey, and the rest to NHS.) There's also plenty of building maintenance at Survey facilities: the Natural Resources Building, engineering lab (west campus), print shop, core storage barn, and the labs, offices, and earth samples library in the annex (south farms).

The expertise of Glogowski's diverse group is supported by state-of-the-art equipment, including the latest information technology. "Everyone has access to e-mail and the Net," he says, "methods of communication that allow us all to stay on the same page." That's important, he points out, now that most of the GeoSurvey's programs depend on cross-functional teams, enlisting experts on everything from finance to database management for geologic projects like 3-D mapping of the whole state.

Spreading the word

Jonathan H. Goodwin

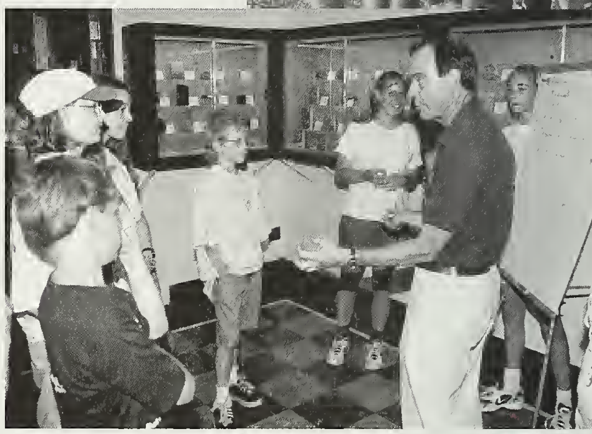
Opportunities to spread the word about the GeoSurvey are better than ever, according to Jon Goodwin, head of Geoscience Information and Communications. His group handles everything from educational events to information technology, library services, and publication production, marketing, and distribution. "Lots of people are working on workshops, posters, Internet publishing, and the ever-popular field trips.

"The Survey is working directly with teachers developing curriculum materials." He adds, "We also offer them a chance to join a geologist on the job for a day or two. Last year, nearly 20 teachers went on the Friday run-throughs of our public field trips. We call it 'job shadowing.'"

The GeoSurvey's best road show, the public field trips, has had a successful run of 67 years. "The trips are a good way to show people how geology affects their lives," Goodwin says.

"Reaching out to as many people as possible in as many ways as possible—that's our mission," he explains. "We have to make geologic research available to the public in the formats they can use for making informed decisions."

Education and outreach are driven by the science. "What we learn through research may well determine who our audience is," he explains. "If we find there's pollution, for example, from application of some new agrichemical in a certain type of geologic setting, then we have to communicate with the Department of Agriculture, the Farm Bureau, county health boards, and all the other areas impacted by our discovery."



At a sand and gravel pit, Jon Goodwin explains the fossils in a chunk of gravel to a family on the Lake Shelbyville field trip. At the mineral exhibit on the first floor of the GeoSurvey, Goodwin tells some 4-H kids, "Minerals are the building blocks of rocks."

The heart of the message

"Our writers and editors make sure everyone can understand our research, whether it's published in a science report or in GeoNews," Goodwin says. "Our newsletter is one of the best vehicles for communicating our complicated science to the public."

From the standpoint of distribution, the public information staff works hard at marketing—letting people know that a new publication is available.

This year, full-color maps and posters have been hot items [p. 13]. "We've taken advantage of the opportunities opened up by desk-top, digital technology to create products that communicate to the general public," he says.

Internet communication is big too. The GeoSurvey's web page had 4,000,000 hits in 1997–1998, four times the number for 1996–1997 [p. 16]. "Clearly, we're facing an electronic revolution in information transfer," Goodwin says. "But the popularity of our workshops and field trips tells us that the best way to get our message across to people is still face to face."

Designer, par excellence

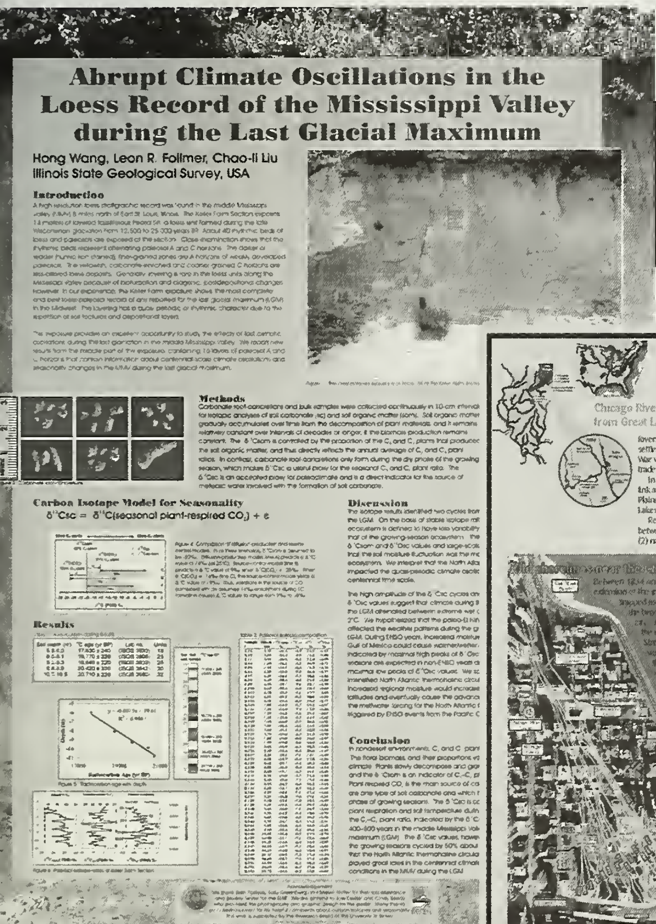
Sandra K. Stecyk, 1937–1998

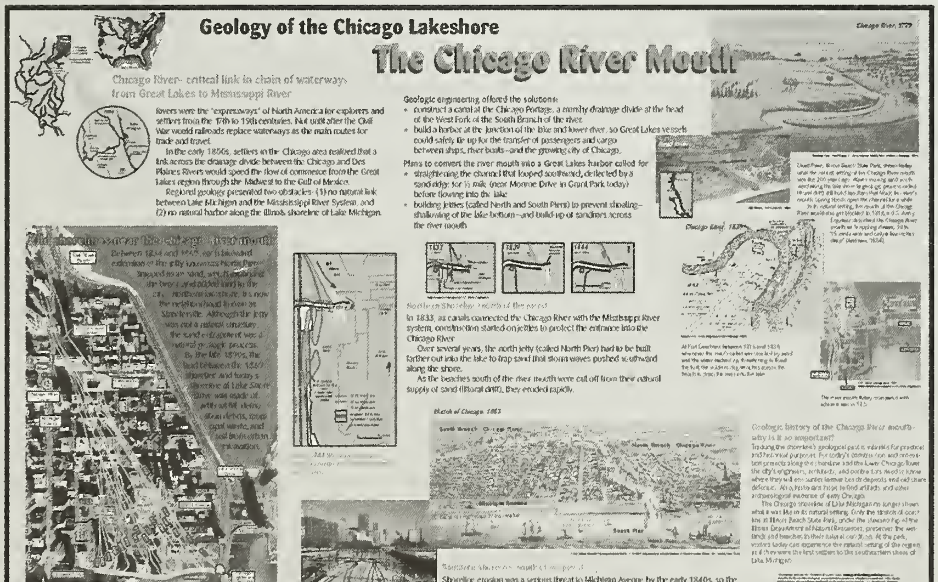
"There's always been a very strong sense of community in how we work together," Sandy Stecyk said about her 20-year career in graphic art and design at the Illinois State Geological Survey. Here's how her clients and colleagues felt about her:

- "Consultation" best described her style of art design and production. She would look over a project and, in a few moments, give sound advice and pertinent, highly useful ideas.
- We admired her competence, efficiency, and ability to translate a sprawl of maps, electric logs, graphs, and photographs into high-quality, professional presentations and publications.
- Cover designs always told a story about the content of a report.
- The design process was supported by a great command of language. Her review of text often equaled that of the editors.
- Always cheerful and happy, she found humor in almost any situation—which made working with her fun!
- Sandy Stecyk was a professional. She always gave you this kind of don't-bother-me-with-the-small-stuff-just-tell-me-what-you-want look as you approached her with something that should have been brought to her days earlier. Then she would look at what you had, point out the obvious flaws, and meet your unreasonable time schedule with a clear, uncluttered illustration that enhanced what you were trying to say.

We will miss her.

Outreach and Education





Maps make basic information accessible. Posters give it an educational spin.

Left to right: Designer of "Abrupt Climate Oscillations," Cindy Briedis. Designer of "Chicago River Mouth," Pam Carrillo. Designer of the first in the series of new annual reports, Sandy Stecyk.

Great weekend deals

That's how one amateur geologist from a Chicago-area rock and mineral club describes the Saturday trips through different geologic regions of Illinois. "The people who lead the field trips are so good," she says. "They don't make us feel dumb. They try to explain so everybody can understand and participate." She smiles: "What I truly enjoy the most—the gravel pits."

Left to right: On the Morris field trip, Grundy County, people take a close look at a glacial moraine on the north side of White Willow Road. On the Elizabeth-area field trip, Jo Daviess County, a bedrock outcrop draws attention. At a sand-and-gravel pit in the Lake Shelbyville area, two girls unearth some interesting mineral specimens.

67 years of public field trips: geology for people

Wayne Frankie, Russ Jacobson

Last year, more than 800 field trippers accepted the GeoSurvey's invitation to four all-day excursions to explore the geology of Illinois.

People came from all over the state to be geologists-for-a-day. Property and business owners, teachers and students (K–college), rock hounds, fossil collectors, and cave explorers joined the caravans winding from stop to stop at the Kankakee River State Park (fall and spring trips), Cache River area in Johnson and Pulaski Counties (fall trip), and Hamilton-Warsaw area in Hancock County (spring trip).

At each stop, field trip leaders talked about how the geology of the site fits into the regional setting (called "geologic framework"). Areas that are natural habitats for wild plants or animals, or the focus of other critical environmental and economic issues, were also pointed out to field trippers. There were minerals and fossils to collect, local caves and quarries to explore, scenery to enjoy, and opportunities to talk with scientists from the Geological, Natural History, and Water Surveys.

A free, illustrated guidebook describing the regional geologic history and the sites along the tour is handed out to people as they register.

To find out how to join our next field trip, call 333-ISGS or visit our web page:

http://www.isgs.uiuc.edu/field-trips/98-99fieldtrip/98-99fieldtrip.html

Near and Far Sciences in Illinois: workshops for K-12 teachers

Janis Treworgy, Mike Chrzastowski, Brandon Curry, Joe Devera, Wayne Frankie, Jon Goodwin, Sallie Greenberg, Dave Grimley, Ardith Hansel, Russ Jacobson, Myrna Killey, Dennis Kolata, Don Mikulic, Bob Vaiden, Pius Weibel , LeAnn Benner

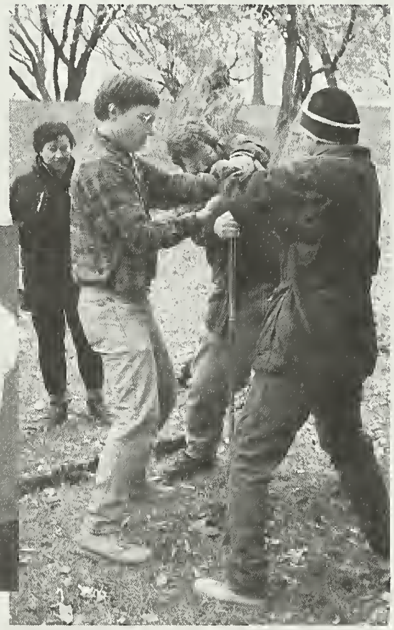
When geology, astronomy, and meteorology were added to the Illinois Learning Standards for Science, the Illinois State Board of Education realized that K-12 teachers might need refresher courses in these topics. That led to creation of the program called Near and Far Sciences of Illinois (NFSI).

The GeoSurvey was asked to run workshops on the geology of Illinois. In 1997–98, 160 K-12 teachers participated in seven 2-day workshops conducted by teams of Survey scientists. To deal with the geology of distinct regions, each workshop was held in a different part of the state: Alton, Ullin, Rock Island, LaSalle, Chicago, Lombard, and Joliet.

Lectures, hands-on exercises, demonstrations, and a full-day field trip to local areas of geologic interest were all part of the workshops. Topics focused on Illinois and covered the basic principles of geology, geologic history, mineral and water resources, earth hazards, and geology in relation to society.

Each teacher received a large packet of materials, including a geology textbook, several maps, and write-ups of activities for classroom and field.

The teachers, who earned graduate credit for their participation, all gave the program rave reviews.



On a blustery day, 20 Chicago teachers taking a NFSI workshop gather around coastal geologist Mike Chrzastowski, as he talks about erosion along Lake Michigan's southern shoreline. In a classroom exercise, geologist Janis Treworgy works with teachers testing silt, sand, and clay to see how fast fluids pass through them. The question is, which earth materials would be best at a landfill site? In Chicago's Lincoln Park, workshop participants crank a hand auger through layers of fill material, as they try to get down to the water table.

❖ Teachers who took NFSI workshops in 1997–1998 tell us that they're making good use of the information and materials we gave them. Now earth science projects with their students are more creative and rewarding. In fact, one teacher received a $10,000 Toyota Tapestry Grant to support her project.

Attitudes toward teaching geology have completely changed, thanks to their NFSI experiences, say many teachers. They especially liked being out in the field with our scientists, sharing the excitement of geology.

❖ The Illinois State Board of Education is supporting another year of the Near and Far Sciences of Illinois program. Workshops will again be held in five regions of the state: Chicago, Rock Island, Alton, Joliet, and Lombard. The 1998–1999 season is sure to be another big success.

Illinois Natural Resources Geospatial Data Clearinghouse

Dan Nelson

In 1997–1998, more than 30,000 users from around the world visited the GeoSurvey's web page in search of computerized data about Illinois' geology and mineral resources. Thanks to the Geospatial Data Clearinghouse, they could download data via the Internet.

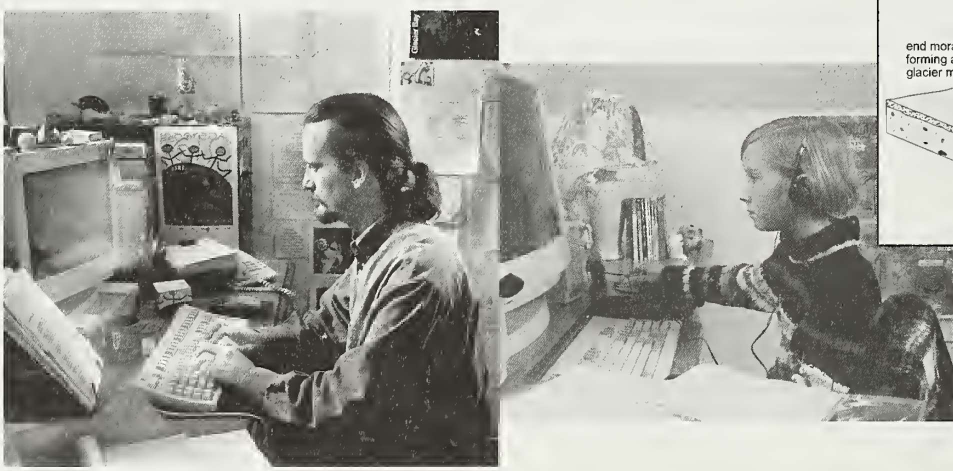
Available through the Clearinghouse are 1,900 GIS (Geographic Information System) data sets and documentation relating to Illinois. It is one of more than 80 similar websites that make up the National Spatial Data Infrastructure (NSDI).

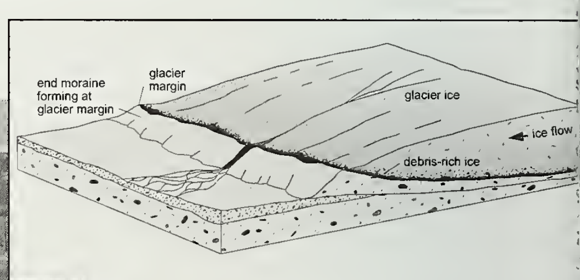
From the Clearinghouse site, researchers, students, engineers, and the general public downloaded about 22,000 data files on subjects including political boundaries, nature preserves, wildlife areas, well locations, mines, land cover, roads, cities, aquifers, groundwater, mineral resources, soils, and other geologic materials.

The site is a cooperative effort of several agencies of the Illinois Department of Natural Resources (DNR), and it is regularly used in GIS-training classes sponsored by DNR and the University of Illinois.

Funding was contributed this year by the Illinois Council on Food and Agricultural Research to use geospatial data to promote agriculture and a rural way of life. The initiative will offer farmers and rural communities the opportunity to use digital base maps in precision agriculture, watershed and resource management, and land-use management.

www.isgs.uiuc.edu/nsdihome/ISGSindex.html





Left to right: Dan Nelson. Nicole Butler-Proch, 4th grader, hits the Survey's Home Page while she's surfing the Internet.

Illinois' Ice Age Legacy, a new book in the Geoscienc Education Series, focuses on how glaciers formed th landscape we see today. It describes how continental ice sheets repeatedly move across the upper Midcontinent for 1.5 million years, examines evidence for glaciation, and tells how geologists study the effects of glaciers. The boo also explains how glacial deposits affect environmental issues such as safe water sources, siting of landfills, flooding, soil erosion, and earthquake risk.

Need information on Illinois geology? Go after it with the Net: *http://www.isgs.uiuc.edu*

At the address of the GeoSurvey's Home Page, you'll find:

GeoNews The Survey's newsletter is packed with stories and color photographs of people and projects.

Geobits Short illustrated fact sheets on geological aspects of Illinois range from typical and atypical Illinois fossils, to how the glaciers made the Illinois landscape.

Annual Reports of the Illinois State Geological Survey Read all about what your geoscience agency is doing for the people of Illinois.

Field Trips Every year the Survey leads the public on four, free geological field trips to interesting areas around the state [p. 14]. Online you can find a brochure telling about the trips.

Features An online tour of the Natural Resources Building highlights the geologic materials used in its construction. Another tour shows the National Coal Mine Museum near West Frankfort, Illinois.

List of Publications Maps and publications of the GeoSurvey appear in this online catalog.

Illinois Natural Resources Geospatial Data Clearinghouse You can download data sets from the Geologic Information System (GIS), and access interactive maps of oil and gas fields, available coal resources, and the glacial geology of Illinois.

And there's much more. Come visit.

Buried treasures: digging for fossils in Discovery Park at the Illinois State Fair

"Where did you get all these fossils?"

Only ½ hour after opening, and already 40 kids (from 6 to 60 years old) have picked or shoveled through the "fossil dig" at Discovery Park in Conservation World! The 8- by 6-foot "sandbox" holds fragments of fossil plants (seeds and stems) and animals (corals, bryozoans, brachiopods, crinoids).

A 7-year old with a balloon tied to the back strap of his cap hangs back, and his grandmother nudges him, "Get in there and dig!"

Geologists from the Illinois GeoSurvey take turns working at the fair. People ask all sorts of questions.

"What are brachiopods?"

"Like a clam, except the shells are less symmetrical. There were a lot of brachiopods in the ocean that covered Illinois back in Paleozoic times—about 300 to 600 million years ago."

"What's a crinoid?" asks a 10-year old, matching a small "button" with a hole in the middle to its picture on a handout supplied by the GeoSurvey.

"An animal called a 'sea lily' that lived at the top of a stem attached to the ancient sea floor," says the geologist on duty. "What you're holding is a segment of the stem— sometimes called an 'Indian bead.'"

"Look! I got a bone!"

"Not a bone, but a fossil of some sort—fossil coral."

A grandfather bends down to look at the seed fern his granddaughter just dug up. "It's a beauty," he says. "You've got some real gems in here."

Left to right: People at fossil dig at 1998 State Fair. Trilobite fossils. Intern Brian Scheidt, coached by Mark Hart, prepares a soil sample for analysis in the Survey's Sediments Lab.

Interns apply schooling to real-world research

In 1997–1998, when geologists needed help getting analytical data from all the samples collected on location, they took advantage of a GeoSurvey intern program giving future geologists first-hand research training and experience with professionals well-established in their disciplines.

Here's how it works: Researchers develop job descriptions and learning objectives. Faculty advisors at participating universities match students to the projects. Interns get to work with up-to-date equipment, and gain training and skills in the latest methods while they work side-by-side with scientists. They apply their schooling to the real world.

Twenty students from Illinois State University, Eastern Illinois University, Western Ilinois University, Southern Illinois University at Carbondale, and the University of Illinois at Urbana–Champaign participated in the first year of the program. Several interns have come back full-time to the GeoSurvey, and others have taken jobs in the private sector.

Major three-dimensional mapping program in western Illinois: team approach

Russ Jacobson, Mike Barnhardt, Myrna Killey, Zak Lasemi, Don Luman, Lisa Smith

Near the eastern Adams County village of Kellerville a drill core turns up a tough, dense clayey material. The geologists cutting it open don't quite know what it is, but will after it is analyzed. Whether it might be an important material for some future product will likely not be known soon, but as one geologist said, "You can't use a resource if you don't know it's there."

This western Illinois mapping project exemplifies the new team research approach at the GeoSurvey, as it engages Quaternary, bedrock, and petroleum geologists, as well as clay mineralogists and computer mapping specialists in getting a complete, integrated picture of the region's geology.

The first phase of this project has been mapping the Kellerville and Fishhook region in eastern Adams, western Brown, and northern Pike Counties.

What's a quad?

In geologic mapping, a quadrangle is a four-sided tract of land bounded by lines of latitude and longitude. The size of a quadrangle can be given in minutes: a 7.5-minute quadrangle map, at a scale of 1:24,000, has dimensions of 7.5 minutes for both latitude and longitude, and covers 50 to 60 square miles.

Left to right:
Myrna Killey and Rus
Jacobson study a core.
Shaded relief map of
southern Kellerville an
northern Fishhook qua

Identifying groundwater resources is one of the immediate benefits of this mapping because western Illinois does not have the extensive water resources that other parts of the state do. Locating groundwater here is important not only for future water needs, but also to protect these resources from potential contamination through the proper siting of such things as landfills and large-scale hog farms.

Identifying valuable resources, such as oil, gas, and high-quality stone, is another benefit. Several potential sites to mine construction aggregate have been identified. These bedrock resources may become more valuable as stone resources in northern and southwestern Illinois are covered by the type of development that makes mining impossible.

Much of the analysis of the cores being drilled by GeoSurvey crews is being done in a sedimentary analysis lab at the geology department of Western Illinois University (WIU). This sharing is part of the partnership the GeoSurvey has forged with agencies, institutions and businesses, such as the Illinois Institute for Rural Affairs, WIU, Adams County local governments, and utilities and other businesses, to address critical geological issues facing the region.

Information on the western Illinois mapping project can be found at its web site:

http://cait.wiu.edu/iira/isgs/geomapping.html

Geologic mapping for smart growth in rapidly urbanizing Metro-East St. Louis

Joe Devera, Brett Denny, Dave Grimley, Drew Phillips, Chrissy Wiscombe

The GeoSurvey has been mapping quadrangles along the eastern collar counties of the St. Louis region: Jersey, Madison, St. Clair, and Monroe Counties. This initial phase of mapping is covering the most vulnerable and important areas first.

Much of the region sits on karst, a swiss-cheese-like terrain where limestone bedrock has partly dissolved, and groundwater contamination is a significant concern.

Karst may present a problem for new subdivisions, where increased groundwater withdrawals can create or expand sinkholes, as land subsides in water-depleted areas. Elsewhere in the region, mined-out coal fields present problems of mine subsidence. Mapping of these areas is necessary to avoid building on unstable ground.

There is also a need to map the high-quality limestone in the area [p. 38], to guide development over and around this valuable resource.

The rapid urbanization of the Metro-East area calls for the new kind of environmentally focused work now being done by the GeoSurvey. Resource geology is not forgotten though. In the Waterloo-Dupo areas, for instance, this particular mapping project is also looking for anticlines that might contain petroleum.

The skeletal backbone now being mapped began with the extreme northern quadrangles (Grafton, Alton, Elsah), moved to the middle (O'Fallon, Cahokia, French Village, and Millstadt), and will then move south (Columbia, Waterloo, and Renault).

Left to right: Sinkhole terrain in Monroe County. Drill augers for new rig. Chris Wilson, Jim Neal, and new heavy-duty drill rig.

"New" drill rigs shoot for 1,000-foot depths

Jim Neal, Chris Wilson

Field mappers are well equipped for exploration drilling, now that the GeoSurvey has four rigs: a new power probe for pushing sample tubes to 100 feet deep, the B30 Mobile rig for installation of monitoring wells to 75 feet deep, and two heavy-duty rigs once used by the Illinois Environmental Protection Agency.

The former IEPA rigs, Central Mining Equipment (models CME55 and 75), can bore through rock at depth—down to 1,000 feet. Faster, easier coring is the special advantage of the CME75, with its newly added wireline capabilities: drillers can go down 5 feet and pull the sampler out with the cable, without having to lift the whole string of drill rods out of the hole.

The GeoSurvey maintenance team (same team, different hats) made major repairs to the previously owned drill rigs before bringing them home from Springfield. The big rigs will need more upkeep than the smaller B30 and power probe. They also take two to three operators.

Already field-worthy, the CME75 has been used to drill monitoring wells for joint projects with the Illinois Department of Agriculture, and exploration holes for three-dimensional mapping of the Kellerville Quadrangle.

What do all our mapping programs have in common?

POTENTIAL USES!

• Resources: locate groundwater, mineral, and fuel resources.
• Geologic hazards: identify areas of potential subsidence (from underground coal mines and karst topography), landslides, flooding, and seismic risk.
• Groundwater protection: screen and/or assess areas for waste-disposal or treatment facilities, aquifer sensitivity, and potential septic field problems.
• Site capability: screen areas for residential, business, and industrial facility siting.

STATEMAP To support the National Geologic Mapping Act, Congress annually appropriates $22–$25 million, of which 70–75% is allocated to the U.S. Geological Survey for federal mapping projects, and about 25% goes to the 51 states for joint federal/state mapping projects. In Illinois, STATEMAP funds are used to produce two basic types of maps: bedrock and glacial geology.

1997–1998 products: Elgin and Pingree Grove Quadrangles in Kane County (completed); French Village and Cahokia Quadrangles in St. Clair County (in progress).

IGMAP The Illinois Geologic Mapping Program began in 1997—the GeoSurvey's answer to the need for comprehensive, 3-D mapping that goes beyond the basic glacial and bedrock geologic maps to land surface maps (aerial photos, surface topography, and surface materials such as soils). Also included are thickness maps of glacial materials (clay, silt, sand and gravel overlying bedrock), bedrock surface, fuel and mineral resources (coal, oil and gas, sand, gravel, and stone for construction aggregate), and aquifer contamination potential maps. IGMAP is supported by a combination of funding sources.

1997–1998 products: Villa Grove, Vincennes, Kellerville, Fishhook, Crystal Lake, Oak Hill, and Dunlap Quadrangles (in progress), Metro-East area and counties in far southern Illinois (in progress).

CAP The ongoing County Assistance Program provides county officials with geologic information for land-use decision-making: (1) regional, not site-specific, evaluations of geology; (2) 1:100,000-scale maps or larger; and (3) screening for potential landfill sites, natural resources, etc.

1997–1998 products: Carroll and McLean Counties (completed); Lee and Jo Daviess Counties (in progress).

Elgin and Pingree Grove quad maps good for land-use planning

Brandon Curry, Dave Grimley

Kane County planners can now consult two new detailed quadrangle maps (1:24,000 scale) of Quaternary deposits—surficial earth materials as deep as 200 feet and as old as the last glaciers to cover the Midcontinent

For their mapmaking (part of the national program STATEMAP), geologists compiled data from more than 200 boreholes made by engineering firms, water well drillers, and the GeoSurvey. They also drilled 200-foot-deep test holes, one in each quad, then described and analyzed cores of glacial materials pulled from the holes.

In the Elgin quad—back in the "Ice Age"—lobes of ice spread, then melted back often enough to create crisscrossing channels and layers of sand, gravel, and clay. At the north end of the quad, geologists mapped the St. Charles Bedrock Valley, an old river valley eroded into bedrock and buried during glacial times by sand and gravel washing off the ice. These coarse materials yield plentiful water supplies.

In the Pingree Grove quad, shallow aquifer materials are fewer and less significant. The area is dominated on the west by the Marengo Moraine (thick clayey till) and on the east by glacial lake deposits.

Left to right: Near Huntley in the Pingree Grove quad, geologists examine the earth materials deposited during th last glaciation. At a construction site in the Elgi quad, geologists collect samples of lake and swamp sediments containing fossils; the holes were drilled to construct supports for an apartme complex.

Geomappng helps solve erosion problems at Site M in Illinois River watershed

Mike Barnhardt, Don Luman, Chris Stohr, Rick Rice

When the State of Illinois acquired a 16,000-acre site in the Illinois River watershed in 1993, it presented great opportunities for recreational development. But the State also took on a handful of problems, particularly erosion. To help plan development of Site M, DNR's largest contiguous recreational site, GeoSurvey scientists worked with their colleagues at the Illinois Department of Natural Resources (DNR).

Located where Panther Creek and Cox Creek flow into the Sangamon River in western Cass County, Site M has highly erodible loess soil. The creek drainages slope steeply; the area has been heavily cultivated; and water has cut deeply, washing away tons of soil.

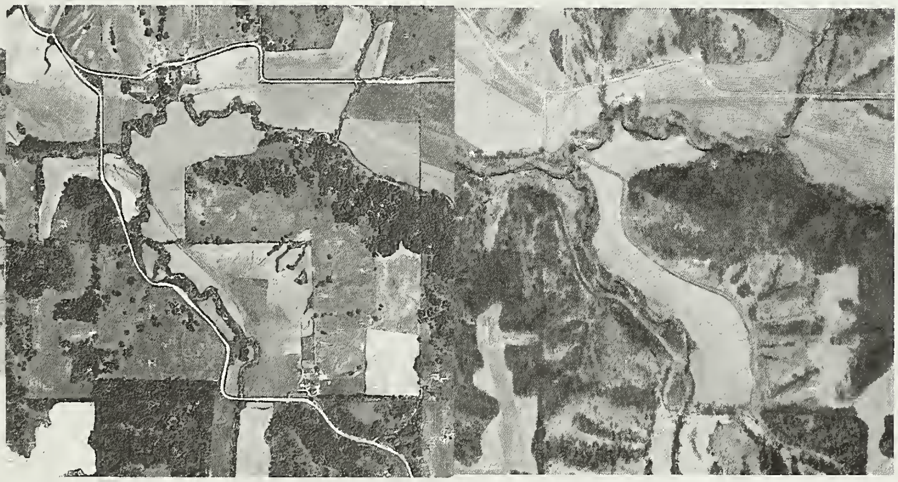
Mapping helped identify areas that should be removed from cultivation, planted in grasses that could help stabilize the soil, or farmed with proper techniques. The mapping also helped define the least costly, most effective erosion abatement strategies.

Recreation facilities, including a 200-acre lake, are still being constructed, and the GeoSurvey is on call to provide whatever mapping or geological assistance is necessary.

This site has to be looked at ecologically and over the long term, say geologists: "We have to look at the whole watershed of 34,000 acres, most of which is outside state land."

Results of the Site M project include

- a laboratory for the study of erosion in the highly erodible loess soils of the Illinois River Valley;
- exact trail maps of the site by using global-positioning satellite technology;
- a demonstration of the GeoSurvey's capabilities for digital mapping. Digital geological maps on demand will assist in park planning, construction, and maintenance for the least impact on both the environment and the State coffers.



eft to right: Geologist ennis Kolata examines a -bentonite (ancient volcanic sh) bed. Site M: aerial hotos taken in 1938 and 990 show the erosion that as occurred.

Ash beds—markers for geologists

Dennis Kolata

About 450 million years ago, near what is now the southern Appalachian mountains, some of the largest volcanos ever known to man spewed tons of ash into the air. Southeast tradewinds blew the ash across the shallow inland sea that covered the midcontinent and carried it as far as what is now Minnesota and upper Michigan. The ash settled and is now buried between layers of rock strata.

Using a variety of tests, supplemented by drill cores and logs, Survey scientists can identify these ash layers (called K-bentonites) by their mineral and chemical composition.

The ash fell within hours from Pennsylvania to Iowa, and this small duration of time makes the ash layer one of the best time markers available to geologists. Like a 400-million-year-old page from a desk calendar, the ash layer can be used to date layers lying above and below it, as a distinct marker for matching strata from widely separated locations, or to indicate where strata are missing from the geological record.

Geoprobe drill rig, another Survey workhorse

Dan Adomaitis, Mark Hart, Charles Dolan

GeoSurvey staff in the Environmental Site Assessments and Engineering Geology Sections have long relied on hand augers and soil probes to bore down to depths of 15 feet and check for contamination. That labor is now being eased by the Geoprobe, a hydraulic direct-push drill rig that sits in the bed of a pick-up truck and runs off the diesel engine.

The Geoprobe saves time in the work the GeoSurvey does for the Illinois Department of Transportation. IDOT needs to know what kinds of soil or groundwater contamination might be present before excavating for road work, both to ensure worker safety and to avoid the purchase of impacted property.

Due to its versatility and popularity, the Geoprobe is booked for months in advance. As a result the northern Illinois field office in Westchester is getting a second direct-push drill rig. Much environmental work performed from that office is in the Chicago metro area and involves drilling through "fill" material, which is commonly dense and difficult to penetrate.

When not being used in the IDOT project, the Geoprobe is proving useful for other projects. Where bedrock is relatively close to the surface, it provides a simple, quick, and effective way to map the bedrock surface. The drill rod is simply pushed into the surficial deposits until it hits bedrock, thereby corroborating readings from various geophysical methods as to the depth to bedrock.

The GeoSurvey's Geoprobe crew holds the world drilling-depth record for pulling core samples. The probe drilled to104 feet deep near Metropolis and retrieved a complete core sample.

It's also proven useful for placing monitoring wells and collecting soil cores at DNR's Lake DePue wildlife management area. The relatively light, maneuverable Geoprobe gets into sites where a full-sized drill rig might have a lot of trouble.

Charles Dolan uses the Geoprobe to take soil samples in the Chicago area. More than three-quarters of the environmental site assessments performed by the GeoSurvey for the Illinois Department of Transportation are in urban areas. Sites to assess are chosen after archival research indicates where gasoline filling stations, industrial plants, and other common sources of soil contamination were once located. Finding bad soil contamination at these sites is not uncommon, according to geologist Dan Adomaitis.

318 acres of lake floor mapped for fishing reef

Mike Chrzastowski, Brad Ketterling, Chris Stohr

Last May, the GeoSurvey's coastal geologists mapped the underwater site proposed for a fishing reef 1 ½ miles off Chicago's southside lakeshore. The artificial reef is the first of several planned for recreational fishing off the Lake Michigan shore, according to the Illinois Department of Natural Resources.

A global positioning system (satellite link) was used to pinpoint the boat's position and navigate along a series of 40 east-west survey lines about 100 feet apart. The last time a continuous record was made of lake-bottom features in this area—34 years ago—the profile lines were 1,000 feet apart.

Sampling of lake-bottom sediments produced a mixture of sand, gravel, clay, and live zebra mussels.

The lake-bottom maps and sediment samples were used in several ways:

- selection of a specific site for reef construction;
- placing three boreholes for pulling cores of materials to be tested for strength in supporting the reef;
- baseline data for evaluating changes in the lake floor after construction of the reef.

❖ *Lake-bottom mapping for the proposed fishing reef provided new information on lake-bottom morphology and dynamics in this area. A previously unknown ridge-like feature, possibly related to the local late glacial history, was discovered in the map area. Also, comparison of the new sonar data with data collected in 1964 allowed determination of the extent and degree of lake-bottom erosion that has occurred in this area during the past 34 years.*

❖ *In the spring 1998, lake-bottom samples were collected to determine the characteristics of the sediments near the offshore site proposed for the fishing reef. Geologists found a mixture of sand and gravel, although in some places, the underlying clay was exposed too. Almost all the samples contained live zebra mussels—one more verification of how their population has exploded in southern Lake Michigan.*

❖ *Coastal wetlands and North Point Marina, a State recreational area in Lake County, are now protected by a new submerged breakwater. The lake bottom near the underwater structure was surveyed by the Survey's coastal geologists.*

Lake Michigan Shoreline

eft to right: Drifting ands: Lake Michigan's earshore zone, between ne beach and water epths of about 20 feet eep, is mapped each year long about 10 miles of horeline between the linois–Wisconsin state ne and Waukegan arbor. Geologist Brad etterling collects a ample of lake-bottom ediment. Construction of submerged breakwater vill slow shoreline rosion off North Point Marina.

Lake Michigan levels up 1 foot in 1997: beaches lose, lake floor gains

Tony Foyle, Mike Chrzastowski, Brian Trask

Along the Lake Michigan shore, from the Illinois–Wisconsin state line to Waukegan Harbor, the Survey's coastal geologists have been monitoring changes in the beaches and shallow lake bottom (to 20 feet deep).

In 1997, year 3 of a 4-year study for the Illinois Department of Natural Resources (DNR), lake level was up 1 foot over last year's high water mark. High water—the highest recorded in a decade—partly submerged beaches along 75% of the shoreline and, in some places, washed away dunes.

Although the beach areas lost sand, the nearshore lake bottom gained it. Lake-bottom mapping and depth measurements showed that a bar–trough feature, migrating toward the land, had increased the volume of sediment offshore.

The net gain of sediment in the nearshore zone (between the shoreline and 20-foot depth) is the first documented since 1988–1989. DNR uses the information for management of coastal sand resources.

"The wild card in our deck of geo-hazards is earthquakes," says Don McKay. "Geomapping has helped us identify areas where near-surface earth movements along faults may have occurred much more recently than we thought, maybe a few thousand years ago, during or since the last Ice Age. Before this mapping we thought the youngest surface offsets were tens of millions of years old."

Left to right: Geologist John Nelson explains to GeoNews writer, Stuart Tarr, how and where data are being collected in the search for faults in the rocks underlying Massac County. Ground-penetrating radar pulled across the fault area registers any earth displacement. Map shows the study area in the Illinois Basin.

Earthquake research in southern Illinois

John Nelson

The water wells of farmhouses tucked into rolling hills along Illinois route 145 in Massac County are good sources of geologic data. Most of these farmers hit bedrock at about 150 feet. But when Mr. Weaver, putting in a water well, drilled 340 feet without hitting bedrock, Survey geologists mapping earthquake faults took note.

Drill holes in the area began turning up anomalous formations—strata seen nowhere else in Illinois. These indicate that sediments formed in swampy depressions or grabens, where the earth dropped between two faults in a series of earth movements.

The results from seismic surveys and ground-penetrating radar studies reveal that faults have likely ruptured and displaced relatively young sediments as recently as 15,000 to 75,000 years ago, toward the end of the last Ice Age.

The faults are in the Fluorspar Area Fault Complex, primarily in Massac County, and are in line with the New Madrid Seismic Zone in Missouri. Geologists suspect that these areas are connected and are investigating to see how the fluorspar area faults relate to the New Madrid Seismic Zone.

GeoSurvey discovers deeply buried faults in Illinois Basin

John McBride

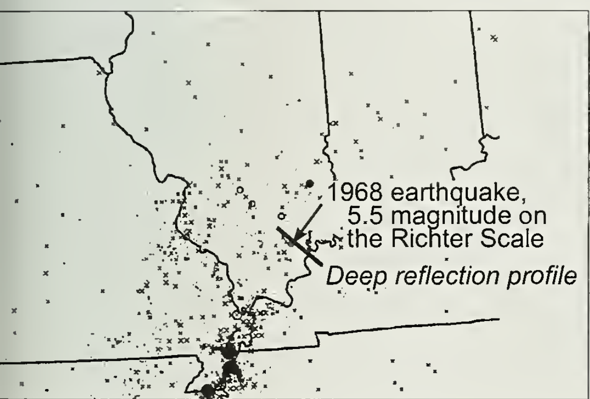
Although the Illinois Basin is one of the world's most intensively studied geologic provinces, not much was known about deeply buried faults that could govern earthquakes. Seismic reflection profiles (geophysical exploration data), collected originally by private industry to look for oil in the Illinois Basin, have recently been used by researchers at the GeoSurvey and the University of Illinois to search for the cause of deep earthquakes in the Midwest.

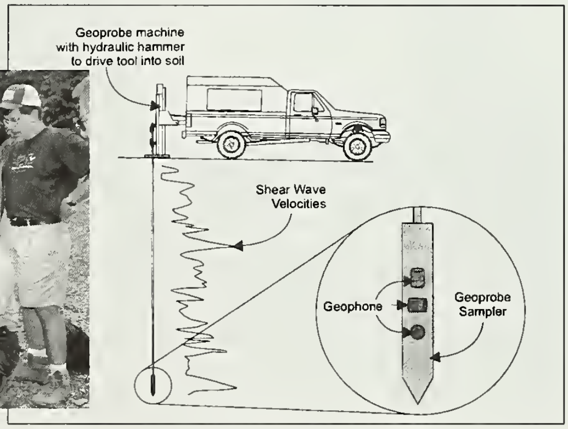
The results were surprising. Modern-day earthquakes may be reactivating blind thrusts deep beneath the Illinois Basin, perhaps analogous to the blind thrusts responsible for the recent, destructive earthquake in Northridge, California.

Reprocessing the seismic reflection profiles has shown that this sequence of faults is much larger than previously thought, and an extensive sequence of blind thrust faults exists beneath southeastern Illinois. This sequence of blind thrusts corresponds closely to the focus of southern Illinois' 1968 earthquake, the 20th century's largest magnitude quake in the central Midcontinent.

Subsurface data emphasize that the faults of the Midcontinent region geometrically resemble the faults of the Rocky Mountains, and that the faults have a long history of reactivation. Surface mapping shows that many have been reactivated, even within the past 2 million years, so they have a potential for seismic displacement when earthquakes occur in the future.

Because this study shows that moderate earthquakes in the Midcontinent can reactivate fault surfaces, detection and mapping of these features in three dimensions is essential for assessing seismic risk.





eft to right: Map showg the seismic reflection rofile across the 1968 arthquake epicenter; dots epresent all known earthuakes greater than 2 on e Richter Scale. Bill hilts, Wen June Su, and on McKay look at earth ulting and folding evience in Massac County. raphic shows the Georobe/geophone invention at quickly assesses soils r their capacity to mplify shaking during n earthquake.

GeoSurvey invention for earthquake risk assessment

Wen June Su, Bob Bauer, Tim Larson

Because soils can amplify earthquake shaking by 3 to 10 times more than occurs at the top of the bedrock surface below the soils, it's important to identify local soil conditions and their ground motion response during earthquakes. For the Central United States Earthquake Consortium (CUSEC), the GeoSurvey is constructing earthquake soil amplification and ground motion response maps.

This mapping is needed for earthquake preparedness in the state, but getting adequate data can be costly. A solution was found by building an inexpensive device to be used in a method devised by the GeoSurvey.

The device, which consists of three geophones assembled into a package that can be lowered down holes dug by the Geoprobe, has several advantages. One is cost. The survey estimates it will cost about one-tenth that of using traditional drilling and seismic equipment. Another advantage is that the Geoprobe drill rig [p. 22] is very mobile and quick. It can do the measurements by the roadside on public land, and it can reach less accessible spots.

The three geophones, which sense seismic waves, are arranged in a vertical and two horizontal directions to pick up wave velocities when a seismic shock—in this case, due to striking a post with a sledgehammer—is introduced. The data the geophones pick up are transmitted to a seismograph at the surface, and then used in analyses for earthquake preparedness.

"*We tend to take clean, abundant water supplies for granted in this part of the country.*

"*Not to have water and be desperate for it is something most people don't experience, but it happens. We see the look on people's faces after they've drilled three or four dry holes—they see us as their last hope.*

"*So, next time you want to buy some land without access to public water, make sure you know its potential for groundwater resources.*"

- Tim Young

Groundwater Resources and Service

Left to right: Drilling for water. Typical rural subdivision.

Looking for water in Peoria County

Pius Weibel

When high-priority areas of the state were identified for geological mapping, the Oak Hill Quadrangle in Peoria County was near the top of the list. Looking out over the wooded landscape of the quadrangle, northwest of the city of Peoria, one can see why: rural subdivisions are popping up all over the area.

Identifying water supplies is a major element in mapping the area. This mapping, which has been going on here for more than a year, will be useful for locating water and determining the amount available. A problem in the area is that the glacial drift is not particularly thick in places, and the sand and gravel aquifers may be too small to support much housing. In areas where the drift is thick, small lenses of sand and gravel perched atop a dense clay layer may trap and hold enough water for domestic supplies in most years. But perched aquifers will often fail in a dry season, once the water table drops.

In one subdivision, developers reportedly needed to drill to bedrock to supply sufficient water for residents. But water from fractured bedrock in this area tends to be saline and high in mineral content, which makes it less than ideal for drinking.

Map information like this is what county planners can use when determining where new housing might be built.

Locating groundwater to serve future generations

Bev Herzog, Curt Abert, Dave Larson, Tim Larson, Steve Sargent, Mary Mushrush, Rick Rice

The Geological and State Water Surveys analyzed and mapped part of the Mahomet Valley aquifer in Tazewell and McLean Counties. Combining the field work of mappers with three-dimensional computer modeling, the Surveys were able to map an aquifer system that can serve Bloomington–Normal and many rural communities into the foreseeable future.

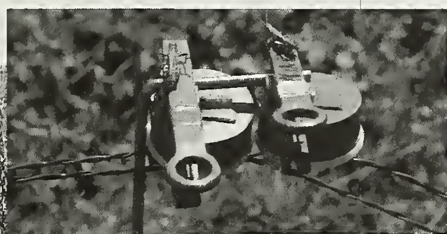
The Mahomet Valley Aquifer is a major water resource in east-central Illinois, but not all areas can tap into it.

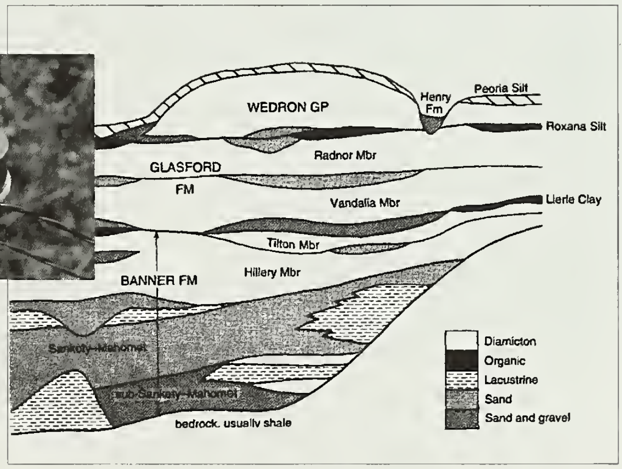
The same GeoSurvey team is mapping the groundwater resources of De Witt and Piatt Counties and adjacent areas. Some parts of these counties are too far from the Mahomet Valley aquifer to economically aquire water from it. Fortunately, there are other water-bearing sand and gravel deposits in the area.

The current study, requested by the Mahomet Valley Water Association, is mapping the location and thickness of these deposits in the Glasford and upper Banner Formations. The mapping will also allow landowners to determine whether they can use small drilled wells.

In areas with thin sands, large-diameter wells may be required to provide an adequate supply. One disadvantage of large-diameter wells is that they are more prone to contamination because they are difficult to seal.

❖ *Two other groundwater projects currently taking place are assessments of aquifers for the city of DeKalb, which needs new supplies to dilute its naturally radioactive water supply, and technical support to the village of Dwight in Livingston Country in their search for a needed supplemental source of water.*





eft to right: Steve argent laying out EER nes in Piatt County; rasshoppers sit on witch boxes that con- ol impulses between ectrodes and com- uter. Cross section of ınd and gravel eposits, including the juifers, in McLean ounty.

Walking the line

Steve Sargent

High tech can carry the objective only so far. At some point, you have to move the troops across the ground. The GeoSurvey uses high-tech equipment, but when you get down to it, mapping takes a lot of walking.

When gathering data for the groundwater availability study of De Witt and Piatt Counties, geologists laid out electrical earth resistivity (EER) lines along a country road near Bement in Piatt County. This was the 426th line, and there were 135 to go to finish this phase of the project. Those 561 lines on a half-mile grid pattern cover roughly the southern half of Piatt County.

Each line contains 26 sensors equally spaced along a 600-foot-long wire that takes readings of the electrical resistance of the materials to a depth of about 200 feet. At the center of the line is a small hand-held computer that registers impulses from each sensor and stores the data for later analysis. When the readings are taken, the field crew walks to the ends of the 600-foot line and begins rolling up the wire, storing the sensors on a belt, then driving a half-mile to the next site to do it all over again.

Along the way, they deal with biting flies, blistering sun, humidity, and occasionally loose farm dogs, who run through the wires and knock down the lines. But it's all part of the groundwork necessary to map the glacial materials and aquifers of the area.

Water, water everywhere and not a drop to drink

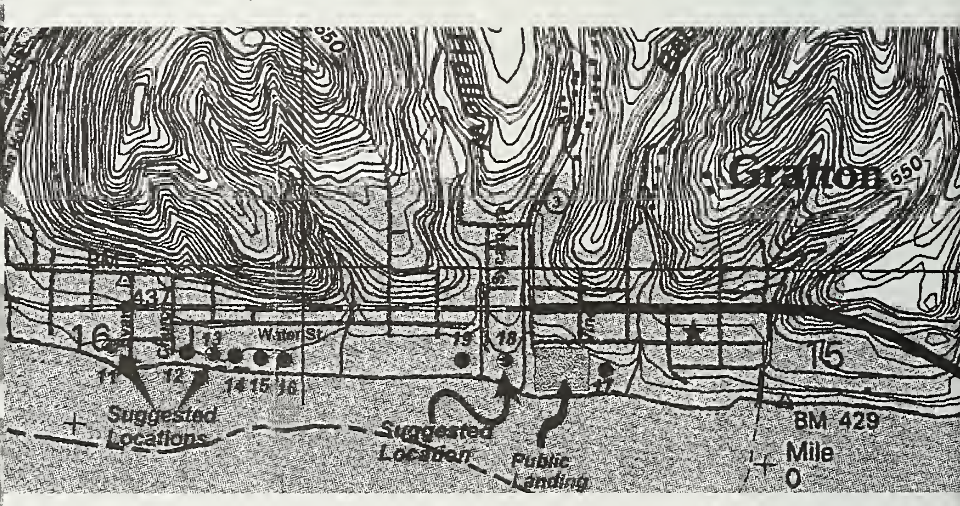
Tim Young

That plea of the shipwrecked also recently applied to Grafton, a Mississippi River town that was among the hardest hit by the great flood of 1993. A major consequence of the flood was damage to the wellheads of the city water supply. Even before the flood, the quantity of water was barely enough to serve the town, and it made sense to put in new wells and a water treatment system, especially since much of town was relocated to higher ground.

The town moved the treatment plant up from the bottom of the floodplain and drilled a test hole to put in the wells. When they hit bedrock at 25 to 30 feet, an extension of the limestone bluffs along the river, they called in the GeoSurvey.

Geologists conducted an electrical earth resistivity survey parallel to the river for about 3 miles. Three locations were recommended for test drilling. With the first test hole, they hit water—a 50-foot deposit of sand and gravel close to the treatment plant.

Left to right: City official looks at soil sample with Tim Young. Topographic map of Grafton shows the contour of bluffs above the town along the Mississippi River and locations of wells, test holes, and resistivity soundings. Location 18 is where the thick aquifer was found. The sand and gravel deposit here probably formed from materials eroded out of two hollows.



GeoSurvey's service helps town develop

The GeoSurvey service that helps Illinois residents find water began in the 1930s and is still going strong. Groundwater geologists, who respond to these requests say, "We get plenty of requests to keep us running all year." The small Shelby County town of Stewardson is an example. Because the town was growing, but their water production was not, Stewardson needed to double their water supply from 100 to 200 gallons per minute (gpm).

The town had drilled a test well where water should have been, but it was a dry hole. With that, they called the GeoSurvey for help.

In that area, the geology is quite variable, and the groundwater potential is marginal, so it's costly and not easy to find the aquifers by using only test drilling. But through an electrical earth resistivity survey, a deposit of sand and gravel yielding 200 gpm was found not far from the old well.

Fractures in bedrock—pathways for contaminants

Chris McGarry

Most water supplies in rural Boone and Winnebago Counties are produced from an aquifer in the shallow bedrock of the Galena and Platteville Groups.

This aquifer is rapidly recharged by downward percolation of surface water through fractures and along bedding planes in the bedrock. Surprisingly little is known about the fractures in the bedrock, which are the principal pathways for groundwater movement.

Recently, howver, State agencies determined that shallow groundwater in the two counties is highly sensitive to contamination.

Survey geologists are completing a project, funded by the Environmental ProtectionTrust Fund, that is unraveling the pattern of fractures and their interconnections in the Galena-Platteville aquifer. By examining exposures in roadcuts and quarries, researchers are creating a regional geologic model of the features of the bedrock.

This model and future maps will help predict the movement of groundwater and contaminants through the fractured rocks, as well as help state and local agencies protect and manage their groundwater resources.

Groundwater Protection

.eft to right: To the ight of the road, a ırge natural fault ow filled with sediıent is exposed in a uarry. Slightly cidic water flowing ırough fractures for ɛns of thousands of ears created this ncient cave, now choked" by debris left y glacial meltwater. . GeoSurvey team ıstalls monitoring vells in the DePue Vildlife Management rea.

Tracking metals in sediments and groundwater in the DePue wildlife area

Dan Adomaitis, Keith Carr, Anne Erdmann

In 1983, a portion of Lake DePue was dredged to deepen the lake for recreational uses. The dredge spoil was pumped into ponds formed by levees in the DePue Wildlife Management Area. The Department of Natural Resources (DNR) now manages the area to attract waterfowl during duck hunting season.

In 1992, the Illinois Environmental Protection Agency alerted DNR to the possibility of elevated levels of metals (especially cadmium and zinc) in the dredged material from the lake. Several years later, DNR found high levels of metals in the sediments and soils of the wildlife management area.

The Geological and Water Surveys are helping DNR identify and quantify metals in the sediments in and around the wildlife area, and is investigating the likelihood that metals could contaminate groundwater and migrate outside the containment levees.

This year, a Survey team added 21 monitoring wells outside the levees to the 24 placed in the ponds in 1997. Knowing the distribution of metals and their potential to migrate will aid DNR in long-term management of the site.

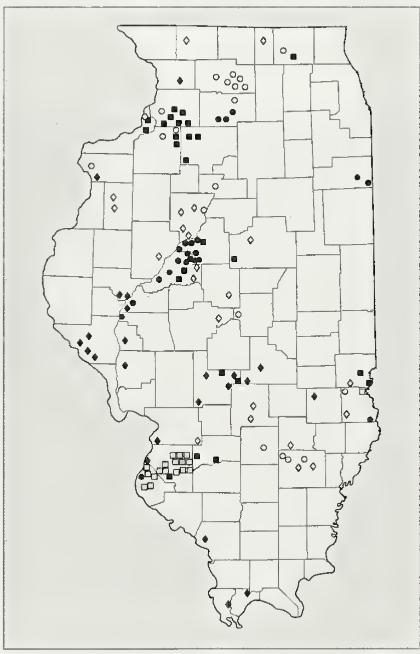
Monitoring statewide for pesticide contamination

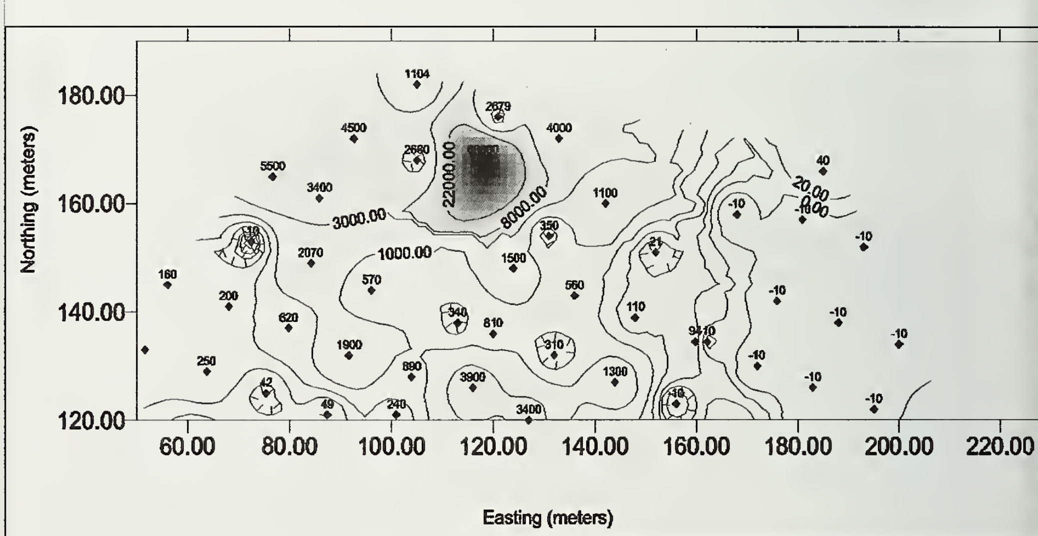
Ed Mehnert, Bill Dey, Don Keefer

The GeoSurvey's groundwater geologists, working with two Water Survey scientists, are halfway through a major statewide program of monitoring groundwater for agricultural pesticides. This program, one of the largest of its kind, will eventually consist of 225 monitoring wells installed and tested.

At about $3,000 per well, the project will be expensive as well as time-consuming. But the benefits will be very significant for future generations of Illinois farmers. Funded by the Illinois Department of Agriculture, the study seeks to determine whether there are mappable geological variables involved in the movement of agricultural chemicals into shallow groundwater.

The study could prove useful for helping the U.S. Environmental Protection Agency decide whether to ban or restrict the use of certain pesticides and other farm chemicals. This proactive monitoring, providing basic data, might be useful in limiting restrictions to areas found susceptible to groundwater contamination. This would help mitigate the negative economic impact that such restrictions would have on Illinois agriculture.





Left to right: Sites for a statewide pesticide contamination monitoring program. Observed and estimated concentrations of a pesticide in soil samples at an agricultural chemical dealership.

Leaks, spills, and splashes add up to high risks for agrichemical facilities

Mike Barnhardt, Don Keefer

In 1993, 49 agrichemical facilities in Illinois passed inspection for on-site contamination. Samples from four test holes drilled at each site showed only two sites with detectable concentrations of the compound atrazine.

Two GeoSurvey scientists wondered whether denser data coverage would reveal more wayward chemicals. In a 1996–1998 study funded by the Illinois Department of Agriculture, they focused on two locales: site 23, where the aquifer material, sand, was at the surface; and site 28, where clayey till was at the surface and the aquifer more than 50 feet deep.

Goals: (1) Find out if any of 62 compounds (herbicides and pesticides) appear only in surface gravel or soil, or can be detected as deep as 15 feet. (2) Identify high-risk zones, where activities like loading and storage produce leaks, spills, or splashes.

Laying out a grid at each site, they bored 15-foot-deep holes every 40 feet. Analyses of four samples per boring gave them the desired density of data. Results: sandy site 23 has surface contamination everywhere; clayey site 28 has three hot spots at the surface. At both sites, detections dropped with depth, but concentrations of compounds were significant.

Controlling "rain" helps track pesticide movement through the soil

Manoutch Heidari, William Roy, Ivan Krapac, Don Keefer

During long periods of below-normal rainfall, agricultural chemicals may be "stored" in dry soil. Then during a heavy rainfall, the agrichemicals can be flushed into the groundwater system and suddenly contaminate the upper zone of an aquifer.

A GeoSurvey team is studying the movement of pesticides through unsaturated soil above the water table. They had created a mathematical model to predict pesticide movement into groundwater. Their model worked using hypothetical data, but they wanted to test the model using data obtained from a controlled field experiment.

For their experiments they faced the problem, "How do you control the rainfall?"

Their solution? This year they built a "rain exclusion" shelter over a farm field and installed soil monitoring devices. In the shelter—like a Quonset hut without walls—they can create their own drought and flood conditions with sprinklers and measure the movement of rainwater and pesticides in soil.

If their model is reliable, it could lead to revised drinking water standards in rural areas and better ways to protect groundwater from contamination.

Left to right: Rain exclusion shelter. The backwater lakes and tributaries of the Illinois River are filling in with sediments. The sediments preserve a history of human activities along the river—including changing patterns in contamination from agriculture and industrial processes (such as smelting and printing). If these sediments are dredged, some banned chemicals such as DDT and PCVs that are now buried would be brought to the surface and could pose new environmental dangers to the many people who live along the river. That's why we need detailed studies of the sediments—to see what's down there.

Illinois River sediments—should we dredge them?

Richard Cahill, Gary Salmon, John Steele, Yanhong Zhang

For the past 100 to150 years, human activities have added sediments and contaminants to the lakes and backwaters of the Illinois River. Sediments fill the river bottom—threatening water quality, navigation, and natural habitats.

Dredging is often proposed to preserve the Illinois River. But dredged sediments may include high concentrations of industrial and agricultural chemicals, as well as metals such as zinc, lead, mercury, nickel, and cadmium. Impacts on the environment could be significant if bottom sediments are disturbed, dredged to build islands, or disposed in landfills.

Recently, Survey scientists updated a 1986 study by returning to analyze sediment and water samples from 14 locations in the stretch of lakes on the Illinois River above Peoria. They found that concentrations of many metals exceeded recommended levels in the deep, older sediments.

Results of these analyses will help the Department of Natural Resources decide which lakes and pools can be dredged with the least impact on the environment.

Groundwater monitored for contamination from livestock waste lagoons

Ivan Krapac, Bill Dey, William Roy, Jean Suchomski

For 2 years, the GeoSurvey has monitored groundwater near two unlined, earthen lagoons used for treating swine manure. Concern about groundwater contamination in Illinois has grown with the rise of large-scale hog operations, which produce 7 million hogs per year. Lagoons are the most widely used livestock waste treatment technology.

Groundwater at both sites was affected by lagoon seepage. At neither site, however, was there indication of groundwater contamination moving offsite.

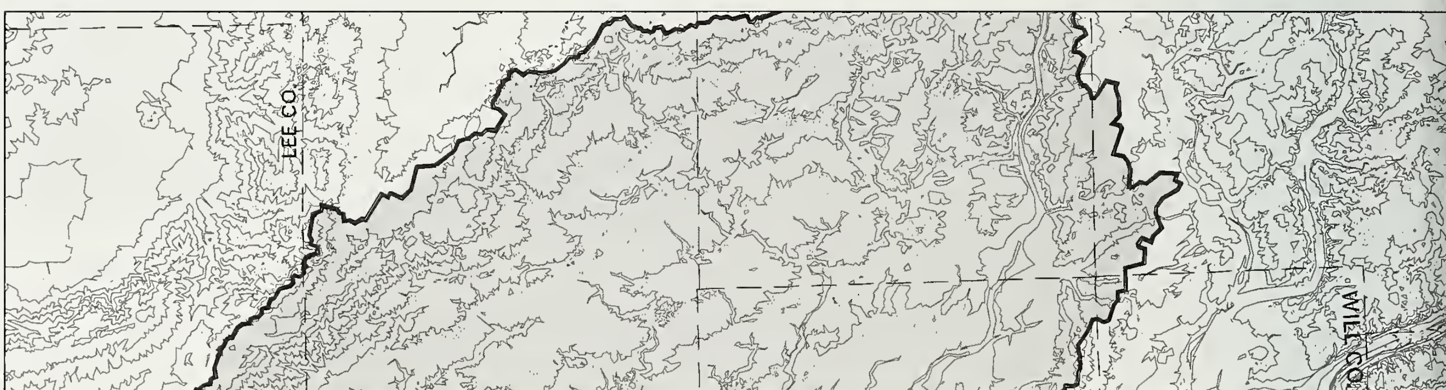
The extent of contaminant migration and the concentration of contaminants in groundwater were significantly greater at the site where there was a shallow, continuous sand layer. This layer likely intersected with the bottom of the lagoon and served as a path to groundwater. (Deeper aquifers, which actually supply drinking water to the area, were apparently not affected by the lagoon.)

This site is considered a worst-case scenario, although contamination was detected no farther than 100 meters downgradient of the lagoon.

At the other site, no continuous sand layer was present. But fractures in the till may be the pathways for some contaminant migration to deeper levels.

Groundwater samples impacted by the lagoons contained elevated concentrations of chloride, sodium, potassium, and ammonia, and depressed concentrations of nitrate and sulfate.

Bacteria such as fecal streptococcus were detected at least once in samples collected at each site. There was a tendency for groundwater in wells containing inorganic contaminants to also contain fecal bacteria. Although inorganic constituents were detected in concentrations greater than drinking water standards, the presence of fecal bacteria poses a greater threat to health.



Section of topographic map the Fox Lake watershed repor

Watershed reports help local groups restore and protect their environments

Myrna Killey, Dan Barnstable, Pius Weibel, Mike Barnhardt, Don Luman, Lisa Smith

When community groups wanted to apply for State grants to help restore and protect their local environments, they got crash courses in the geology of their watershed areas from the GeoSurvey.

The grant program ($3.4-million awarded to 54 organizations) is part of Conservation 2000, a 6-year program to reverse ecosystem degradation through public/private partnerships dedicated to improving environmental conditions in local areas.

Survey geologists wrote reports on the Illinois River bluffs, Spoon River, Driftless Area, Lower Rock River, Sinkhole Plain and Sugar River–Pecatonica watersheds. The reports helped local agencies, schools, churches, and historical and environmental groups develop grant proposals and plan efforts to protect, manage, and restore their watersheds' ecological systems.

The reports describe how geologic materials provide the minerals, rich soil, and groundwater that sustain human life, as well as explain how geologic factors control the distribution of the plant and animal communities in each watershed.

Sections on geologic hazards, groundwater contamination, landslides, mine subsidence, and earthquakes describe how understanding geologic conditions is necessary for maintaining a safe environment.

Monitoring wetland projects

Mike Miller, Phil DeMaris, Christine Fucciolo, Jim Miner
Steve Benton, Alison Meanor

More bridges are being built across the Fox River to ease traffic in rapidly developing areas along the Fox River in northeastern Illinois. One of the proposed sites in Kane County would potentially impact several fens. Because federal environmental law requires that any disturbed wetlands be restored or replaced, the Illinois Department of Transportation (IDOT) must acquire information about the potential hydrologic impacts that this project will have on the wetlands.

The GeoSurvey has a continuing contract with IDOT to assess the hydrogeology in preparation for wetland restoration and creation. When asked to evaluate this site, Survey geologists monitored the chemistry and elevation of ground and surface water to predict the potential impact of the construction and operation of the bridge approach roads on the adjacent fens.

The Kane County bridge project is just one of numerous wetland projects involving the Coastal and Wetlands Geology Unit.

Wetland banks are a major new project. When a wetland is created or restored at a bank site, wetland credits are generated to satisfy wetland replacement requirements that future construction might create. The GeoSurvey has been assigned the job of assessing the hydrogeology and constructing a water budget for these potential wetland banks so that maximum credit from a site can be generated. The first two, both in the metropolitan Chicago area, are now being assessed.

eft to right: aerial photo of gravel quarry ext to Lake-in-the-Hills Nature Preserve, IcHenry County. Christine Fucciolo iecks monitoring wells at this nature reserve. Wetland in McHenry County.

Geologists collect data to help protect nature preserves

Jim Miner, Bill Dey, Mary Mushrush

Many Illinois nature preserves are threatened by development such as mining, industry, and suburban sprawl that may alter the quality or quantity of surface and groundwater. A new joint Geological and Water Survey project provides hydrogeologic expertise to the Illinois Nature Preserves Commission to help determine how to protect these preserves.

Currently, the GeoSurvey's experts in wetlands geology and the Water Survey's experts in groundwater protection and resources are looking at specific threats near preserves under the greatest development pressure. Most of the work consists of collecting baseline hydrogeologic and geochemical data to assess or monitor the potential impacts of proposed or ongoing development nearby.

The geologists' abiotic information is combined with biotic information collected by life scientists from the Illinois Department of Natural Resources; the result is a fuller understanding of natural conditions that support the preserve.

Being proactive is critical for the State to be able to assess the effects of development on a nature preserve.

Isotopes trace landfill gas and leachate

Jack Liu, Keith Hackley

Were gases or leachates from two landfills affecting local groundwater? The operators of the landfills called the GeoSurvey for help in finding out.

Garbage and refuse buried in landfills are decomposed by chemical and bacterial processes, and produce carbon dioxide (CO_2) and methane (CH_4) gases as well as leachate containing inorganic carbon compounds.

The "isotopic signatures" of many compounds are quite different from the background levels found elsewhere in nature. Paper buried in landfills is higher in carbon-14; water has higher levels of tritium (a hydrogen isotope) that probably comes from luminescent paint. Carbon and hydrogen isotope compositions of methane produced by microbial action differ from those of "glacial drift" gas or natural gas.

These distinctive isotopic signatures can be useful markers for telling whether monitoring wells are contaminated with landfill gas or leachate.

Isotope analysis of groundwater near the landfill sites showed that methane was migrating from one landfill and leachate was migrating from the second.

What are isotopes?

All atoms of an element don't weigh the same. A small proportion of the atoms, say of carbon or oxygen, in any sample may have an extra neutron or two in their nucleus, thus giving the atom a slightly higher atomic weight. These are isotopes.

The relative abundance of the isotopes in an element in nature is constant—what's called the "background" level. Measuring the relative abundance of isotopes in a sample can be a powerful tool for identifying and comparing different samples.

Some isotopes are unstable. Over time, they decay and emit radiation. One of the best-known radioactive isotopes is carbon-14. Measuring its decay is a way of dating material that contains organic matter.

Isotope Geochemistry Lab

Left to right: Geologist Jim Schneider, grad student at Northern Illinois University, stands amid the construction debris at the Columbia landfill site. Isotopic analysis showed the debris was not the source of the high level of sulfates in the leachate. Geochemist Keith Hackley connects a buried soil prob to a diaphragm pump. The pump will extract soil gas to be used for isotopic analysis.

Sulfur in landfill leachate: where's it coming from?

Sam Panno, Keith Hackley, Pius Weibel

When the city of Columbia began the process of legally closing a landfill, it installed monitoring wells to provide information about whether leachate from the landfill would be detected in groundwater.

Water samples were taken from observation wells, as well as from seeps, streams, and springs.

When some samples were found to have unusually high levels of sulfates, the question was whether the sulfates were being carried in leachate from the landfill. Most of the refuse in the landfill was construction and demolition debris, such as tires, brick, plastics, plaster, and gypsum wallboard.

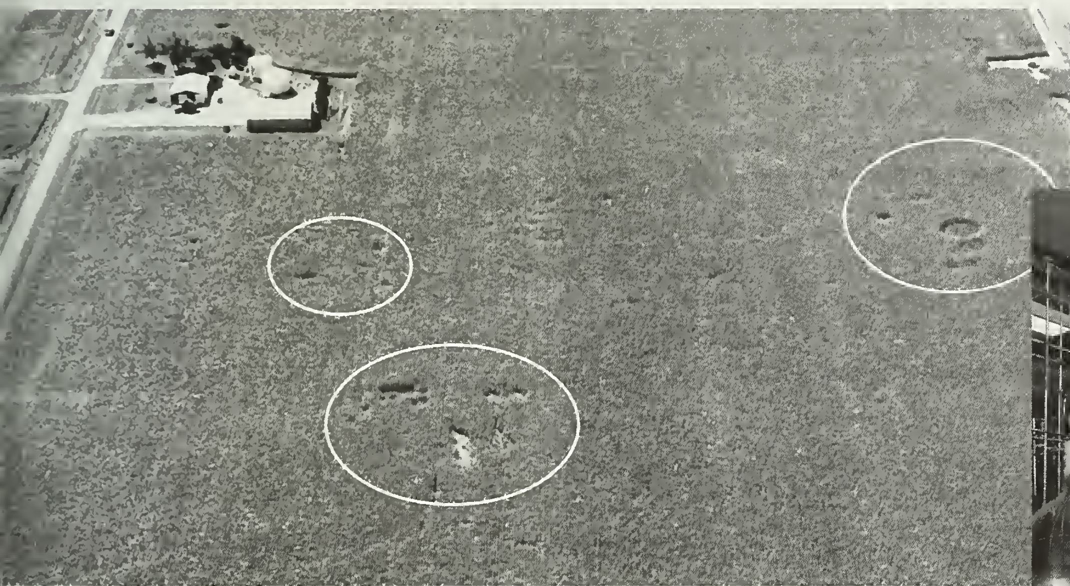
Isotopic analyses showed the sulfur originated from sulfides such as pyrite (fool's gold). The gypsum (a calcium sulfate mineral) in the wallboard was not the source. Most likely, the sulfur comes from naturally occurring nodules or crystals of pyrite near the top of the underlying limestone bedrock.

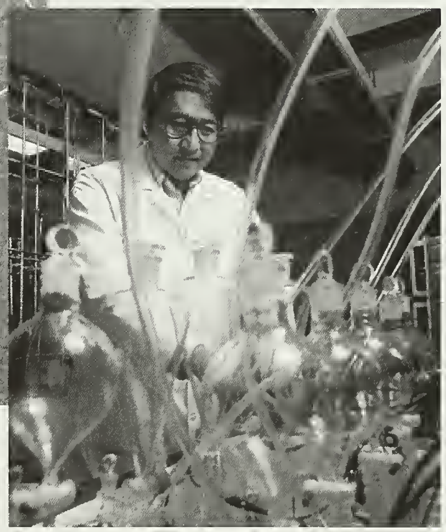
Methane from underground gas storage reservoir

Keith Hackley, Jack Liu, Hong Wang

When a farmer's field had crop damage due to methane gas in the soil, the question was whether the methane was naturally occurring "glacial drift" gas or from an underground gas storage reservoir or a near-surface gas pipeline.

Gas samples were collected from soils, the stored gas, bedrock, stream beds, and wells. Isotopic analysis of the carbon-13 in the gases showed that the methane was rising through bedrock fractures from the underground gas storage reservoir.





Left to right: Areas of crop damage due to rising methane gas. Isotopic analysis showed the gas was rising from an underground storage reservoir. Geochemist Jack Liu at work in the Survey's Isotope Geochemistry Lab.

Timely award to GeoSurvey's isotope geochemists

Jack Liu, Hong Wang, Keith Hackley

The latest prize, a state-of-the-art Flowthrough Compound Specific Isotope Ratio Mass Spectrometer, was recently awarded by the National Science Foundation to a research team from the GeoSurvey and the University of Illinois. While sharing the honors, the University is happy to let the GeoSurvey take home the prize—to operate and maintain the equipment and continue to provide first-rate service.

The new equipment, scheduled for delivery in April 1999, comes at a good time, as the GeoSurvey is starting to conduct research in organic isotope geochemistry. The powerful new instrument gives geochemists the capability to analyze samples of organic materials nearly two orders of magnitude smaller than the smallest samples handled by the present instrument. Analyzing extremely small samples is the name of the game in organic geochemistry.

The high speed and full automation of the new equipment also gives the Isotope Geochemistry Lab an opportunity to offer services to researchers throughout the state.

New combustion chamber: breakthrough in carbon-14 dating

Hong Wang

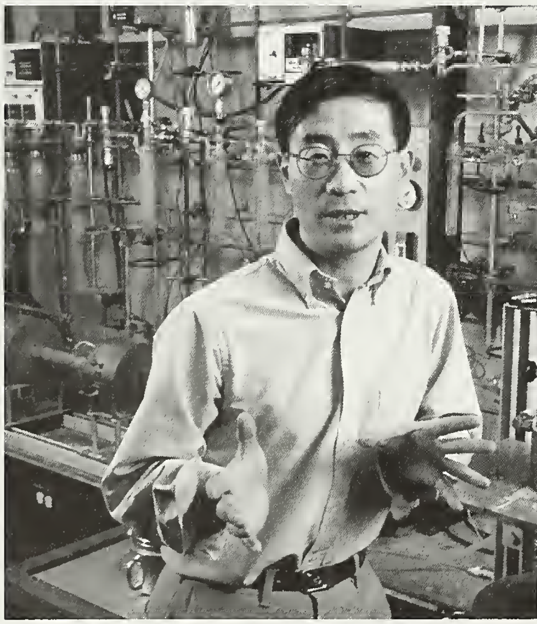
Carbon-14 dating, the well-known method for dating ancient artifacts, depends on measuring trace amounts of the radioactive carbon-14 isotope found in plant or animal material.

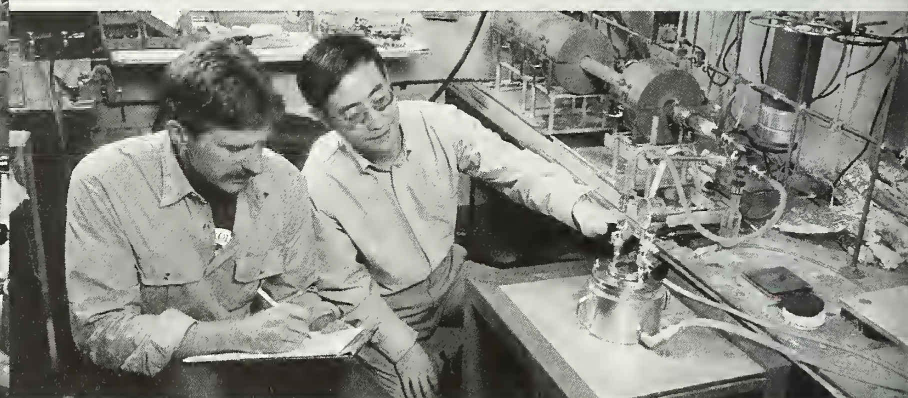
But the method has rarely been used for dating ancient soils (paleosols)—not because there's no organic matter left in these "fossil" soils, but because conventional methods must process large numbers of samples to get enough carbon-14 to measure. Even then, accuracy is limited because of the chance of contamination.

The GeoSurvey's Isotope Laboratory has built a new large-capacity combustion chamber that can burn 6½ pounds of material, instead of just less than ½ pound. This chamber has made for two breakthroughs in carbon-14 dating.

The accuracy of dating is now extended back to 50,000 years ago, and samples (such as ancient soils) can be dated even though they have extremely low organic content (less than 0.1%).

The technique is already being put to use by geologists who study glacial sediments. It's a powerful tool for dating paleosols.





Left to right: Chemists Hong Wang and Keith Hackley in the Isotope Geochemistry Lab.

Environment of early man in China

Hong Wang, Jack Liu, Leon Follmer

Early man migrated out of Africa and reached Asia before about 1.8 million years ago. By about 1.2 million years ago, man had moved out of subtropical climates onto a temperate plateau in central China.

In a collaboration with the University of Illinois' anthropologist, Stanley Ambrose, the Isotope Lab studied ancient soil samples from strata associated with fossils of early man in this region of China. Ratios of the stable isotopes of carbon and oxygen from organic matter and carbonates in ancient soil (paleosols) were studied and used to reconstruct the plants, animals, and climate of early man's environment in this region.

Results suggest that early man had permanently occupied temperate (non-tropical) regions in eastern China about 650,000 years ago, some 150,000 years earlier than in Europe.

100–200 calls, letters, and e-mails per year: "tell us all you know about mineral resources"

Jack Masters, Zak Lasemi, Don Mikulic, Randy Hughes, Subhash Bhagwat

Every year, the GeoSurvey helps people asking about stone, sand, gravel, and minerals in Illinois.

Aggregate and other mining companies, big and small, need regional data for help in finding high-quality deposits to develop or expand operations.

Landowners ask about mineral deposits on their property, usually because a company's interested in buying or leasing their land for mining.

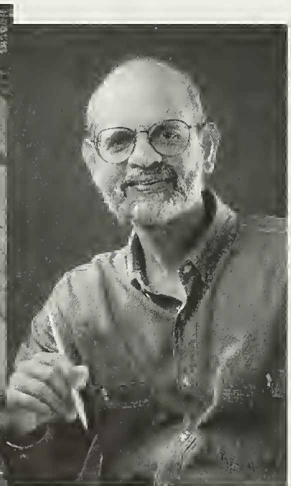
County officials deciding on changes in the zoning of an area, say from agricultural to mining, need to know whether there's a potential for minerals.

Companies, landowners, or government officials get the same information. Nobody gets an advantage. The specifics on any parcel of land appear in a regional context—what's known from drill-hole and water-well records, and geologic mapping of the area.

Field service ("come out and take a look") must be mutually beneficial; for example, GeoSurvey people get to study a new quarry exposure, and quarry operators get expert appraisal of the quality and regional trend of the rock resource.

Lately, school kids are using the Internet to contact the GeoSurvey. A typical question: "Please tell me all about fluorite deposits in Illinois."

Industrial Minerals and Resource Economics



eft to right: Thorton 'uarry, Cook county. lineral economist ubhash Bhagwat.

❖ *Where will high-quality aggregates be mined in the future? When quarry operators need a regional perspective, they contact the GeoSurvey's experts in aggregate resources. The State's geologists examine rock cores from the most recently drilled holes at the quarry, and on site, advise operators and consultants on overall trends of the critical rock resources.*

❖ *The Illinois Association of Aggregate Producers (IAAP) is working with the GeoSurvey to set up a cooperative working group on industrial minerals. There's a big need to bring Survey scientists involved in water, environmental, engineering, and mineral resource research together with the IAAP, mining companies, and government agencies.*

The group's proposal for an "8-Point Program for the People of Illinois" has been signed, sealed, and set for delivery in the coming years.

❖ *Safety training, part of the 8-point program, has already started. The first of the IAAP-sponsored training sessions was conducted last spring for GeoSurvey staff who need to work at pits, quarries, and mines.*

> *"Our geologic studies of land assist the market to function optimally, regardless of the land-use decisions made by citizens." -Subhash Bhagwat*

❖ *Loss of local sources for high-quality aggregate pushes up the cost of local construction and road-building, as the cost of trucking in stone from a distant quarry inflates budgets.*

Other consumers also feel the loss. High-quality, finely crushed limestone is used by industries and coal companies to neutralize acid wastes, and by power plants to remove sulfur from gases emitted by burning coal. Farmers add agricultural lime to their fields to restore the chemical and nutrient balance of soils.

For finding new deposits of high-quality rock, nothing is more valuable than aggregate resource maps.

Ice Age sand dunes in Kankakee County: good idea to mine?

Subhash Bhagwat, Jack Masters, Randy Hughes, Latif Khan, Phil DeMaris

The possibility of mining the sand deposits has been on the agenda of Kankakee County's development council since the 1970s. Last year, the GeoSurvey was asked to update a 1974 report on the mineral potential and economic feasibility of mining, as the prelude to current land-use planning.

After a field study (sampling five 20- to 35-foot boreholes on two test sites) and lab analyses (74% silica sand, 21% feldspar, and 5% "other"), the GeoSurvey's minerals engineers integrated the new data with the data and lab work from the 1974 study.

Three alternative process flows and economic scenarios were proposed for potential products ranging from foundry sand, amber glass, abrasives, hydraulic fracturing (oil production), filtration systems, and ceramics.

The results were promising, but new sand producers in the Midwest face a competitive market.

"Information about the land's value as a source of minerals helps landowners," says mineral economist Subhash Bhagwat, "because it contributes to a fair assessment of land price.

"If mining takes place, economic benefits accrue in the form of jobs and royalties paid to landowners. If instead, the government purchases the land to create a nature preserve, economic benefits may accrue to the area by increasing tourism and attracting new homeowners."

Left to right: Limestone mine, southwestern Illinois. Geologists Rod Norby and Zak Lasemi examine rock cores at a drilling site. Sand dunes, Kankakee County.

Costs of crushed stone, as far out of sight as the nearest quarry

Zak Lasemi, Rod Norby, Joe Devera, Brett Denny

Towns in the Metro-East region of Illinois, across the Mississippi River from St. Louis, are expanding fast. The GeoSurvey is trying to keep ahead, working at top speed to map the geology and mineral resources around Alton, Grafton, Columbia, and Waterloo—before the land is subdivided and paved over.

Aggregate resource maps are derived from geologic maps by using data from analyses of rock in drill cores, bedrock exposures, and quarries.

Dealing with Mississippian-age carbonate rocks in this region, mappers are developing new criteria for distinguishing units because (1) the quality of the resource differs with each formation, and (2) the quality of a single formation can vary greatly. In one place, the Salem Formation may be a good source of high-calcium limestone; in another place, it's better for construction aggregate.

Thickness of formations also varies from place to place. Around Alton, the Salem Limestone is 60 to 80 feet thick; but it gradually thickens to about 200 feet for about 180 miles southward to Prairie du Rocher.

In general, both quality and thickness increase toward the south.

Petroleum problem-solving workshop: how to get more oil out of the Illinois Basin

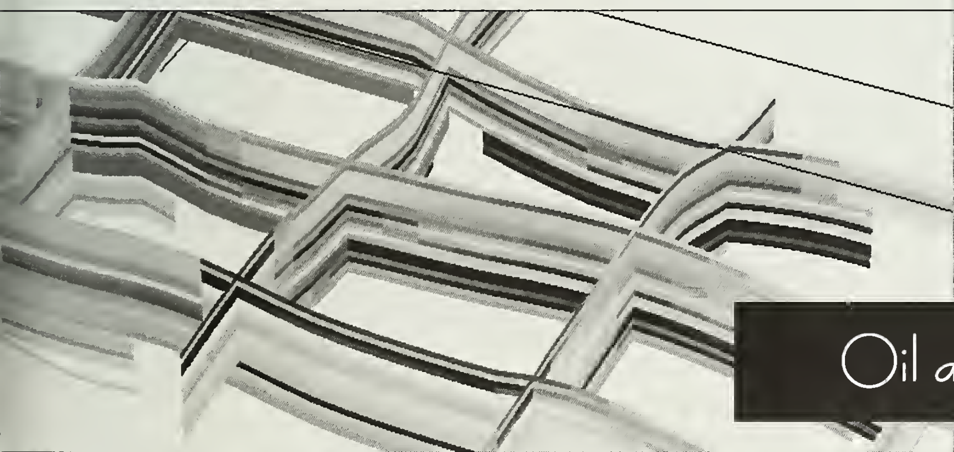
Dave Morse, Tom Davis, Hannes Leetaru, Bev Seyler, Emmanuel Udegbunam

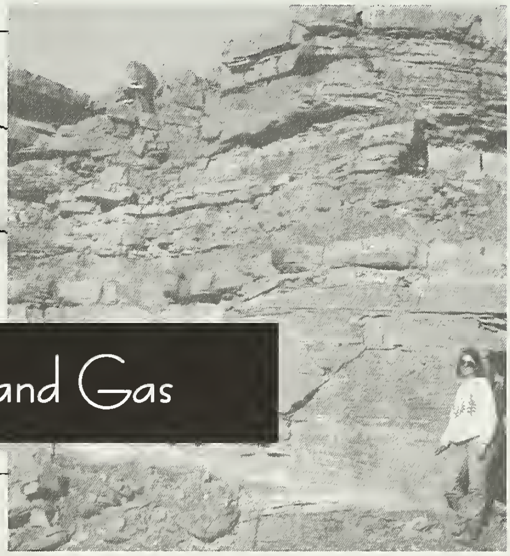
The GeoSurvey, as Midwest headquarters for the USDOE-funded Petroleum Technology Transfer Council (PTTC), conducts four to five technical workshops per year—all focusing on how to get more oil out of the Illinois Basin.

Last March, at a workshop in Williamson County, the Survey's oil and gas researchers analyzed the Aux Vases Sandstone, one of the best oil-producing zones in the Basin. Fifty people, many representing small oil companies operating in Illinois, attended the 2-day event. After reviewing the basics on fields (reservoir characteristics, oil and gas production, waterflooding), workshop leaders covered sequence stratigraphy (what rock formations lie over and under each other), engineering parameters and rock-core data (porosity, permeability, water-to-oil saturation), and environments of deposition.

The Aux Vases sandstone, product of a marine tidal environment, forms heterogeneous reservoirs: oil collects in "compartments" that may not be connected. Even in a field with 10-acre well spacing, a producing well may be next to a nonproducer.

The next day, the group toured two quarries where the Aux Vases is exposed in all its complexity—on view for all to see and better understand what's happening between boreholes deep below land surface.





Oil and Gas

eft to right: 3-D model oil reservoir. Hasty uarry in Hardin ounty, visited during a orkshop; the rocks hind petroleum ologist Bev Seyler are ux Vases Sandstone.

All-purpose mapping software

Hannes Leetaru

Oil and gas researchers recently acquired a new version of Landmark's software for subsurface data management and mapping. The package is part of an educational grant awarded jointly to the GeoSurvey and the University of Illinois.

This software integrates all steps involved in characterization of the subsurface by using data typically available from oil field drilling and testing. With the Landmark package, geologists can bring downhole logs and lithologic descriptions (that is, data on rock types and properties) into cross sections, then transform the well data into a 2-D map or a 3-D model.

Used primarily for oil and gas research, the software could also prove useful for aquifer studies. University of Illinois geology students will learn Landmark to enhance their mapping skills.

Oil independents and consultants get help from GeoSurvey–PTTC partnership

Dave Morse, Tom Davis

Workshops and lots of data—that's what independent oil operators want from the Illinois GeoSurvey. Engineering-oriented events are the biggest draw, as everyone wants to know how to get more oil out of existing fields.

They also need easy access to well logs and information on oil and gas production, waterflooding (flushing oil out of reservoir rock), and analyses of rock core (for porosity, permeability, and water and oil saturation).

In 1997–1998, the GeoSurvey and Petroleum Technology Transfer Council (PTTC) sponsored four workshops in Illinois: topics included geostatistics, unconventional gas resources (shale gas and coal bed methane), pressure transient testing, and the Aux Vases Sandstone oil reservoirs.

Left to right: Tom Davis, who runs PTTC's Midwest office. Art Sanders and Dave Morse at the Eastern Section of the American Association of Petroleum Geologists. Hannes Leetaru working with Landmark software.

> *Access the PTTC website from ISGS Home Page*
>
> Information available for Midwest region:
> - oil and gas regulations
> - up-to-date well-drilling permit information
> - wireline logs for Illinois—newly released to the public
> - training videos to check out
> - petro software for download
> - key links to oil and gas industry
> - links to Michigan, Indiana, and Kentucky Geological Surveys and their data.
>
> ISGS Home Page:
> http://www.isgs.uiuc.edu

Drill-core analyses and oil-well data, heart of petroleum database

Tom Davis, Dave Morse

Illinois Basin oil-and-gas data are being compiled and stored digitally to make the GeoSurvey's records more useful.

Well record data, the scout ticket information not yet in the database, consist of production statistics, initial well production, oil-producing formations, formation tops (elevations for mapping), and much more.

Core analysis data can be used by operators to help evaluate new properties. These data (including porosity and permeability) can be used to help calculate the volumes of oil reservoirs; 60,000 core analyses have already been entered into our database.

Both types of data are essential for making economic, scientific, and engineering decisions about oil reservoirs and fields. For this ongoing service to the independent oil industry, the GeoSurvey will continue to seek additional data.

Coal programs benefit Illinois, nation, industry

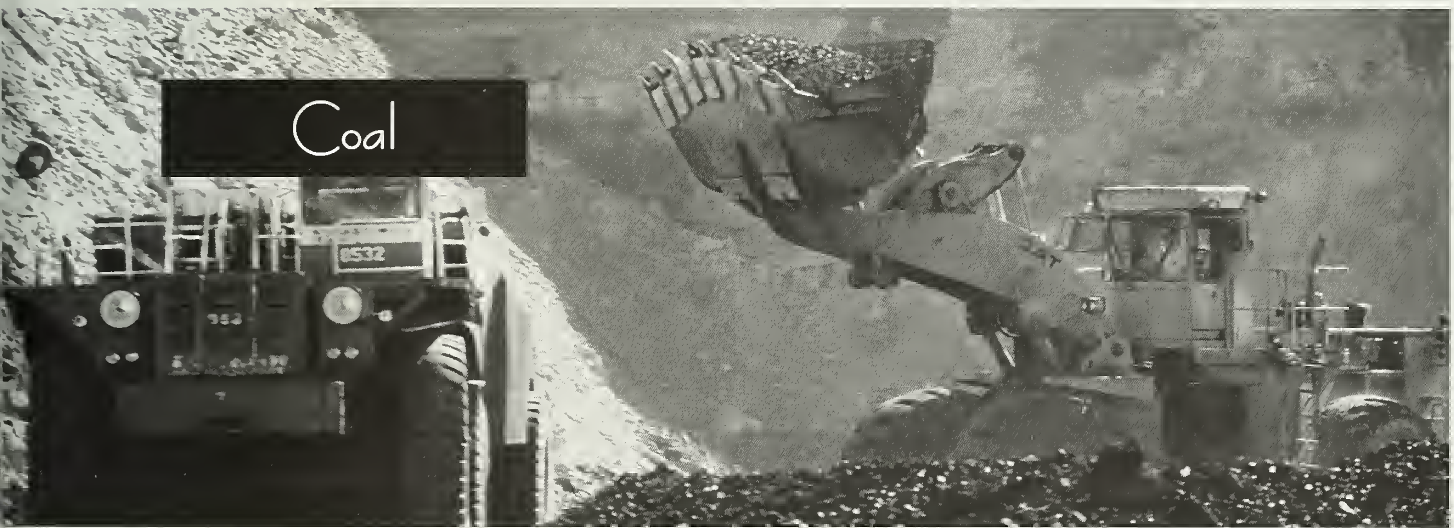
❖ Many Illinoisans are unaware that the largest coal deposits east of the Mississippi River are in Illinois. The coal industry continues to be a major provider of high-wage jobs downstate and could become more important to future generations.

❖ Coal now provides more than 60% of electrical generation nationwide and will remain an important part of the Illinois economy.

❖ New data on the Danville, Herrin, and Springfield coals, compiled as part of a U.S. Geological Survey assessment of national coal resources, will be useful in examining trends and planning new mines.

❖ Subsurface geologic mapping provided key information to a coal company seeking new reserves to keep a mine open in southern Illinois.

More than 100 old mine maps were acquired as a gift from Old Ben Coal Company; the collection includes several only-known maps of some mines. Acquisition of mine maps is part of the Survey's ongoing effort to collect and archive valuable data from the private sector. Also recently added to the collection were 1,000 geophysical logs from Woodell Logging Company and 150 maps of data from Midland Coal Company.



❖ Studies of availability of coal for mining in five more 7.5-minute quadrangles have been completed and published on the web. The five quadrangles are Albion South, Peoria West, Snyder-West Union, Springerton, and Tallula. So far we have assessed the availability of coal in eigthteen quadrangles and we are now taking what we learned from these quadrangle studies and using that information to produce a map for the entire state showing available coal in the Springfield seam. Additional statewide maps of other seams will follow.

❖ Coal mines in the Kewanee North and Tallula Quadrangles are the latest additions to the map series designed to help landowners, government agencies and planners avoid mine subsidence problems.

❖ The GeoSurvey's coal geologists continue to compile data, maps, and reports useful to coal companies, workers, and communities, and for economic projections of coal-mining in Illinois. Accurate information about Illinois' coal deposits is needed for planning by federal and state agencies, communities, utilities, mining companies, companies supplying goods and services to the mining industry, and other energy consumers and producers.

❖ Measurements of coal seam elevations have been posted in a digital file on the Web. The data are being used by oil companies to find new structural traps.

❖ GeoSurvey data on coal-bed and coal-mine methane have been organized and made available to operators entering the Illinois Basin to develop these resources.

Putting it back where it came from: fly ash disposal in old coal mines

Ed Mehnert, Mary Jane Richardson

One of the problems with burning coal to generate electricity or for other uses is what to do with the fly ash, bottom ash, and other coal combustion by-products. One proposed solution is to put it back underground.

Ash and other combustion byproducts could be backfilled into mined-out room-and-pillar coal mines.

To test the technical and environmental feasibility of this proposal, SIU-C scientists injected these combustion byproducts into an abandoned coal mine along the Sangamon/Christian County line in the summer of 1997.

The GeoSurvey's role was to monitor groundwater and groundwater flow and to model the movement of contaminants. The groundwater monitoring provides current information about groundwater quality at the waste-injections site; modeling tests different scenarios to predict groundwater quality in the future. The modeling results also can be used to design more efficient groundwater monitoring programs.

The study indicated that movement of contaminants out of the mine is very unlikely. Modeling results showed that contaminants could not be moved from the mine under realistic conditions.

Left to right: Undergrou coal mine. Field of tires awaiting recycling.

Use found for waste tires

Massoud Rostam-Abadi

Waste tires have long been an environmental problem as they pile up in dumps, breed mosquitos, and occasionally catch on fire. If all were stacked on top of each other they would reach the moon.

One proposed solution has been to recycle these tires by using them as a low-cost source for a new carbon adsorbent to remove toxic materials such as mercury from power and industrial plant flue gases.

GeoSurvey mineral engineers recently made an adsorbent from waste tires. They tested it for its ability to store natural gas, and remove volatile organic compounds and mercury from gas streams.

Adsorption of mercury from the flue-gas stream was greater than with coal-derived activated carbons as well as a commercially available carbon adsorbent. And the cost is about half that of the commercial adsorbents.

The material was also effective in removing volatile organics, which presents a possible market for using them in automobiles to collect and prevent the release of gasoline vapors into the environment. Its ability to store natural gas also presents a potential for lighter-weight, lower-pressure storage systems for compressed natural gas vehicles. But performance of the waste-tire carbon in this application is far from the level needed for commercial success.

New froth flotation device improves coal cleaning

Ilham Demir, Latif Khan, John Lytle

Coal that is finely ground during mining, handling, and preparation can cause loss of up to 10% of the coal mined because the fine coal is difficult and expensive to separate and recover from the accompanying mineral matter.

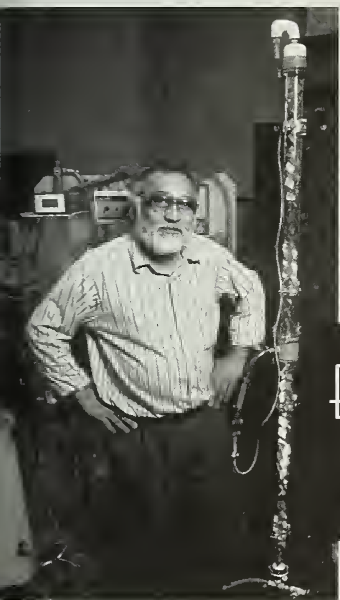
Although expensive, froth flotation is commercially practiced at two plants in Illinois to recover coal fines. The flotation machine creates a froth that carries off the coal while the minerals, which don't stick to the bubbles, go with the fluid out the bottom.

A froth washer being developed at the GeoSurvey is capable of substantially improving the economics of commercial fine-coal recovery and producing an even cleaner coal product. The device, now being fine-tuned, would be a benefit to coal producers who now lose coal fines to slurry ponds.

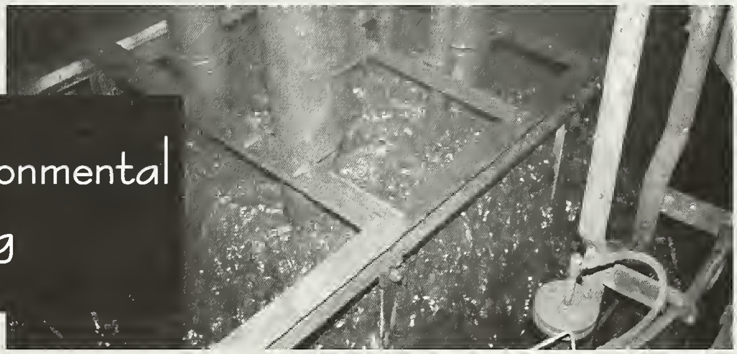
The new froth washer improves coal cleaning in two ways. The froth goes through multiple stages of cleaning, producing a cleaner coal at each stage. Then the mineral contaminants are removed into a separate stream to avoid re-contaminating the froth. Because the froth washer is so effective, it can also increase the capacity of existing froth flotation machines, and further decrease the cost of recovering clean coal.

Removing impurities such as sulfur-bearing impurities from coal (1) improves the coal's heating value for use in industrial and electrical utility boilers, and (2) helps meet federal emission standards for sulfur dioxide—one of the main culprits in acid rain.

The GeoSurvey has tested the cleanability of 34 Illinois coals that came from all parts of the state. When ground to minus 100 mesh, they lose as much as 75% of the ash-forming minerals and pyritic sulfur.



Energy and Environmental Engineering



eft to right: Latif Kahn ·anding beside a froth oatation column. nother type of froth oatation device in ›eration.

Carbon-based sorbents for cleanup of coal-derived gases in coal gasification system

Tony Lizzio, John Lytle,

For advanced coal gasification systems to be successfully demonstrated and commercialized worldwide, a way to remove hydrogen sulfide from hot coal gas is needed. All sorbents (materials that capture unwanted chemicals) examined to date have had at least one major deficiency that prevents their widespread use. These sorbents are only now coming online commercially, and there is ample time to develop improved sorbents and systems for hot gas cleanup.

The GeoSurvey's minerals engineers have been working to determine the commercial potential of carbon-based sorbents produced from Illinois coal. These sorbents have performed at levels comparable with some commercial metal-based sorbents. They also showed little or no change in hydrogen-sulfide removal over a temperature range from 400° to 600° C, unlike the metal-based sorbents, which show a substantial decrease in performance near 400° C.

Char optimization studies of these activated chars demonstrated that they could serve well in removing residual hydrogen sulfide and possibly other air toxics such as mercury, selenium, and arsenic from hot coal gas. The next generation, hot-cleanup process for coal gasification systems could include activated char working alone or in tandem with zinc titanate or copper oxide to remove hydrogen sulfide as well as air toxics.

High-value byproducts from power plant scrubber waste should help Illinois coal's marketability

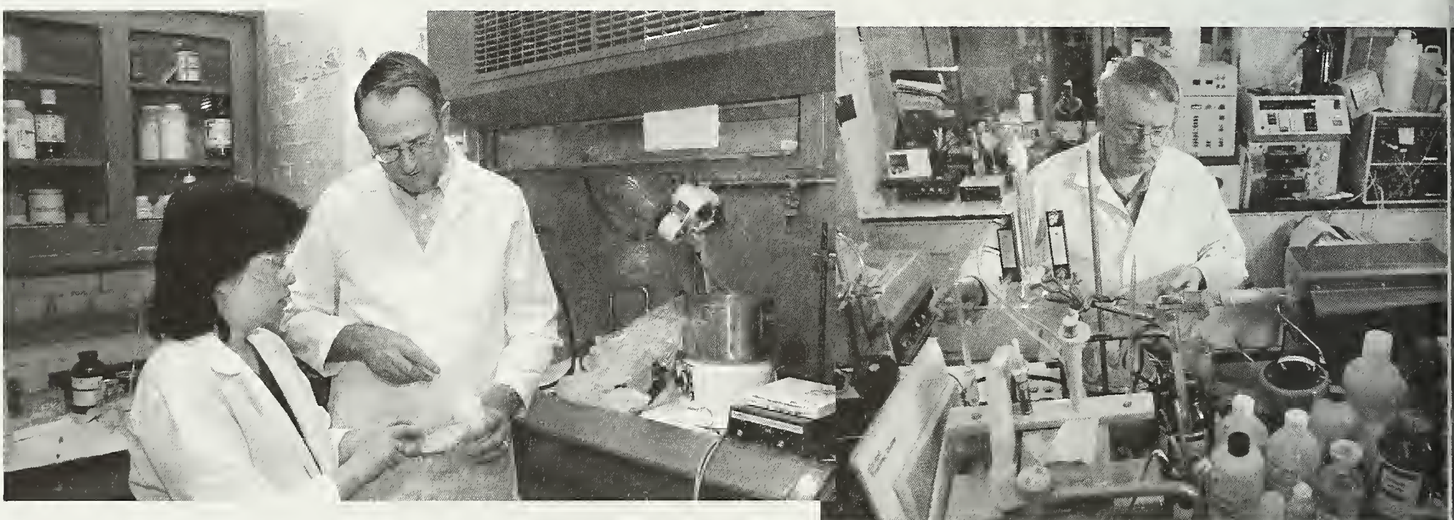
Mei-in Melissa Chou, John Lytle

To combat acid rain, federal law requires coal-fired power plants to remove sulfur dioxide from flue gases. A common method is a wet limestone process, which is effective, but produces a lot of solid gypsum, a compound of calcium, sulfur and water.

A process that converts this gypsum to ammonium sulfate and precipitated calcium carbonate has been developed in the Energy and Environmental Engineering Lab. This year, studies have shown that pilot-scale development should be successful. This exciting development takes a waste product that posed disposal problems and turns it into two marketable products. If successfully applied, this process should make burning high-sulfur Illinois coal more economical.

Ammonium sulfate is a fertilizer that currently sells for $85 to $100 per ton in liquid form. Manufacturing it from flue-gas-derived gypsum using the GeoSurvey process would cost about $85 per ton.

Precipitated calcium carbonate can also be manufactured economically with this process, for high-value use in a variety of industrial processes, including paint manufacturing and paper filler or coating.



Left to right: In the Energy and Environmental Engineering Lab, scientists Melissa Chou, John Lytle, and Gus Ruch develop and test new applications for coal byproducts.

High-chlorine Illinois coal does not cause boiler corrosion, GeoSurvey shows

Mei-In Melissa Chou, John M. Lytle

Many British studies have indicated that chlorine in British coal causes corrosion in boilers. These studies have led many U.S. boiler manufacturers to set a limit for chlorine in coal to be burned in their boilers—a restriction that has reduced the marketability of some high-chlorine Illinois coals.

In 1994, a joint Electric Power Research Institute and Illinois Clean Coal Institute survey of U.S. utilities burning high-chlorine Illinois coal, indicated that chlorine-related boiler corrosion has not been occurring. The GeoSurvey undertook pilot-scale combustion tests to confirm the survey's findings.

The study showed no correlation between the level of chlorine in the coal and the rate of boiler corrosion, although there was a correlation with metal temperature and type of metal used in the boiler. The results suggest that high-chlorine Illinois coals can be successfully used in utility boilers, if other coal components and boiler properties are first understood and controlled.

This news should be beneficial to (1) utilities, who will be able to use high-chlorine Illinois coal; (2) boiler manufacturers as a basis to consider changing their chlorine limits; and (3) the marketability of high-chlorine Illinois coals.

Other active research projects, 1997–1998

Analytical Geochemistry

Alluvial Aquifers: Effects of Flood Conditions, J. Risatti, E. Menhert

Bioremediation of Atrazine-Contaminated Fill, J. Chou, W. Roy

Chemistry and Mineralogy of Illinois Soils, G. Dreher, Y. Zhang, L. Follmer, R. Hughes, J. Steele

Graphite Furnace Method Development for Determination of Pb, Cd, As, and Se in Sediment and Soil Digests and Waters, J. Steele

NASA Exobiology, J. Risatti

Partitioning of Biomethane Pathways in Volo Bog, J. Risatti

Sediment Geochemistry of Upper Peoria Lake, Illinois Portion of the Grand Calumet River, and Champaign County Rivers, R. Cahill, G. Salmon, J. Steele, Y. Zhang

Coal

Anomalously High Moisture Contents of Low-Sulfur Illinois Coals—Occurrence and Causes, H. Damberger, I. Demir, R. Harvey

Availability of Coal Resources for Future Mining in Illinois, C. Treworgy, C. Chenoweth, C. Korose, D. North

Chemical Composition and Origin of Saline Waters in Aux Vases and Cypress Formations, Illinois Basin, I. Demir

Coal-Bed Methane and Coal-Mine Gas in Active and Abandoned Mines of Illinois, H. Damberger, I. Demir, C-L. Liu

Coal Quality Patterns of Illinois Basin Coals, H. Damberger

Database on Illinois Basin Coal Seams, H. Damberger, C. Treworgy

Dinosaurs of the McNairy Formation; Studies of the K/T Boundary in Illinois and Missouri, R. Jacobson, J. Masters, J. Devera

Excess Moisture in Illinois Coal and Its Tax Implications, H. Damberger

Long-Time Gas Desorption Study of Five Coal Cores from Deep Part of Illinois Basin, H. Damberger, I. Demir, R. Harvey, C.-L. Liu

Maintenance of Coal Mine and Resource Data, C. Treworgy, C. Korose, J. McBeth, D. North

Mineralogical and Chemical Composition of Inorganic Matter in Marketed Illinois Coal, I. Demir, R. Hughes, P. DeMaris

Production of Precipitated Calcium Carbonate from Fluidized-Bed Combustion Ash, I. Demir, M. Rostam-Abadi

Engineering Geology

Central U.S. State Geologists (CUSEC) Mapping of the Midwest: Earthquake Risk Management, R. Bauer, W. Shilts

Earthquake Response Team, R. Bauer, T. Larson, W.-J. Su

Geology for Tunneling for Future Accelerators at Fermi National Accelerator Laboratory, D. Gross, R. Bauer

Illinois Loess: Geology and Its Engineering Implications, W.-J. Su, L. Follmer

Review of Historical Land Uses at Illinois Beach State Park, R. Bauer, D. Adomaitis, P. Bannon, K. Carr, M. Chrzastowski

Environmental Site Assessments

DePue Lake Base Maps and Remote Sensing Interpretation for Site Contamination Studies, C. Stohr

Illinois Department of Transportation Maintenance Facility Assessment Program, A. Erdmann, R. Bauer, IDOT Property Assessment staff

Geospatial Analysis and Modeling

County Geologic Mapping Assistance Program (CAP), R. Krumm, C. McGarry, R. Nagy, M. Riggs

Digital Data Distribution to the Public, R. Krumm, A. Lecouris, S. Denhart, B. Stiff, D. Nelson, S. Beaverson

GIS (Geographic Information System) Training of Geological Survey Staff, R. Krumm, D. Nelson, C. Abert, A. Lecouris, C. McGarry, R. Nagy, A. Hettinger, B. Stiff

Wabash Valley Seismic Zone Maps, R. Krumm, L. Smith

Geologic Records Unit

Well Records Management and Information Services, R. Krumm, K. Burris, J. Duncan, A. Faber, B. Lemke, A. Metcalf, T. Vaughn

Groundwater Geology

Agricultural Chemical Contamination of Field Tile Effluent, D. Keefer, W. Dey

Analysis of Pumping Test Data: Large-Diameter Wells, M. Heidari

Assessment of Contamination: Dug Wells in Illinois, E. Mehnert, D. Keefer, W. Dey

Bacterial Contamination of Karst Aquifers, S. Panno, C.P. Weibel, I. Krapac

Transport of Colloids in Groundwater, D. Keefer, E. Mehnert, J. Risatti, S. Sargent

Dilution Stream Gauging in Karst Terrain, S. Panno, C.P. Weibel

Geophysical Services to the Public, T. Young, T. Larson, S. Sargent

Geophysical Surveys to Explore for Groundwater Supplies in the Vandalia Area, T. Larson

Geophysical Surveys to Explore for Groundwater Supplies in the Dwight Area, T. Larson

Groundwater Cave Basins of Illinois Sinkhole Plain: Agrichemical Loading of Fogle Pole Cave Basin, S. Panno, C. Weibel, I. Krapac

Halorespiration as a Means of Enhancing Redox Transition Zone, E. Mehnert, D. Keefer

Northern Illinois Water Company Well Site Studies, E. Mehnert, D. Larson, T. Young, M. Heidari, S. Panno, K. Hackley

Reduction of Nutrients in Groundwater Using Microorganisms, E. Mehnert, J. Risatti

Statistical Evaluation of Data from Multiple-Spill Sites, D. Keefer, M. Barnhardt

Industrial Minerals and Resource Economics

Diagenesis of the Illinois Basin, R. Hughes, D. Moore

Directory of Mineral Producers in Illinois, V. Ipe, J. Masters

Economic Geology and Market Forces; Economic Study of Oil, S. Bhagwat, J. Masters, H. Leetaru

Fly Ash in Glass, R. Hughes, G. Dreher, J. Steele

Geoarchaeological Studies, R. Hughes

Markets for Sulfur, Precipitated Calcium Carbonate, and Fertilizers, S. Bhagwat

Mercury Capture Across FGD Systems, S. Bhagwat, V. Ipe

Sequence Stratigraphy and Economic Significance of Mississippian Carbonates in Western Illinois, Z. Lasemi

Water Resources in Illinois: Supply, Demand, and Prices, V. Ipe, S. Bhagwat

Internet

Maintain and Enhance GeoSurvey Internet Service, S. Denhart, G. Arnold, D. Nelson, S. Beaverson, T. Davis, A. Sanders, M. Krick, K. Mercer, L. Raymond, R. Jacobson, S. Tarr

Isotope Geochemistry

Carbon and Oxygen Isotope Geochemistry of Calcite in Cleats of Coal Seams, C.-L. Chou, H.-H. Hwang, C.-L. Liu

Developing Nitrogen Isotope Analysis Techniques for Dissolved Nitrogen Species in Water, H. Hwang

Geochemistry of Paleozoic Carbonate Rocks in Illinois, C-L. Chou, Z. Lasemi, J. Masters

Geologic Factors Affecting the Abundance Distribution, and Speciation of Sulfur in Coals, C.-L. Chou

Groundwater Ages and Recharge Areas of the Mahomat Valley Aquifer, K. Hackley, S. Panno, C.-L. Liu, K. Cartwright

Isotopic Analysis for Dissolved Nitrate in Water for Source Identification, H. Hwang, S. Greenberg, C.-L. Liu

Paleoclimate Oscillation in Mississippi River Valley, H. Wang, L. Follmer, C-L. Liu, R. Hughes

Minerals Engineering

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Novel Carbons from Illinois Coal for Mercury Removal from Flue Gas, S. Chen, M. Rostam-Abadi, H.-C. Hsi

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